AVIATION WEEK

A McGRAW-HILL PUBLICATION

January 20, 1958 75 cents

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Production Boeing 707

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AVIATION CALENDAR

Jan. 20—Winter Meeting Provisional Western States Section The Combustion Institute, California Institute of Technology, Pasadena, Calif. For details write Mr. G. S. Bahn, Marquardt Aircraft Co., Van Nuys, Calif.

Jan. 20—Information Theory and the Communications Engineer, speaker Dr. Marcel Golay, consultant, Physical Sciences Auditorium, University of Pennsylvania, Philadelphia.

Jan. 20-21—First Annual General Meeting, Association of Local and Territorial Airlines, Washington Hotel, Washington, D. C.

Jan. 20-Feb. 7—Aviation Institute for Commercial Carriers and Business Pilots, Univ. of Southern California, Los Angeles.

Jan. 22-26—First International Air Show & Exposition, Master Field, Miami, Fla. For details write P.O. Box 2879, Miami 17.

Jan. 27-30—26th Annual Meeting, Institute of the Aeronautical Sciences, Sheraton Astor Hotel, New York City. Honors Night Dinner, Jan. 28.

Jan. 27-30—Plant Maintenance & Engineering Show, International Amphitheatre, Chicago.

Jan. 27-31—Engineering Institute's Time Study Appreciation Course, University of Wisconsin, University Extension Div., Madison 6, Wis.

Jan. 28-31—14th Annual Technical Conference, Society of Plastics Engineers, Sheraton Cadillac Hotel, Detroit, Mich.

Jan. 29-31—Fourth Annual Meeting, American Astronautical Society, Main auditorium, Engineering Societies Bldg., 29 W. 39 St., New York City.

Jan. 30-31—Seventh Annual Instrument Short Course sponsored by Southern California Meter Association and Los Angeles Harbor Junior College at Los Angeles Harbor College, Wilmington, Calif.

Jan. 30-31—American Society for Engineering Education 1958 College-Industry Conference, U. of Michigan, Ann Arbor.

(Continued on page 6)

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Vol. 68, No. 3

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AVIATION CALENDAR

(Continued from page 5)

Feb 2-7—American Institute of Electrical Engineers Winter General Meeting. Hotel Statler New York City.

Feb 3-4—Industry Services Symposium Flight Control Panel Integration. Biltmore Hotel Dayton, Ohio. For details: Mr. J. H. Kearns, Box 942, Dayton.

Feb 10-14—American Society for Testing Materials Committee Week, Hotel Statler St. Louis, Mo.

Feb. 17—1958 Conference of Professional Divisions American Society of Mechanical Engineers. Theme: International Geophysical Year—Technology at the Threshold. Hotel Huntington-Sheraton, Pasadena, Calif.

Feb. 19—Are Flying Saucers Fact or Fancy? Dr. Hugh Wynn, Missile and Ordnance Systems Department GF Engineers Club, Philadelphia, Pa.

Mar. 13-14—Second National Conference on Aviation Education. Hotel Mayflower, Washington, D. C.

Mar. 17-20—Joint Aviation Conference, American Rocket Society, American Society of Mechanical Engineers, Statler Hilton Hotel, Dallas, Tex.

Mar. 17-21—1958 Nuclear Congress, managed by American Institute of Chemical Engineers, 25 W. 45 St., New York City.

Mar. 18-19—Conference on extremely high temperatures (over 30,000K), sponsored by USAF Cambridge Research Center, L. G. Hanscom Field, Bedford, Mass.

Mar. 18-19—First Interscience and Industry Symposium on Guided Missiles Training Equipment (limited to those with Secret clearance). Naval Ordnance Laboratory, White Oaks, Silver Spring, Md. For details write: Mr. J. C. Vaeth, Head of New Weapons & Systems Division, U. S. Naval Training Device Center, Port Washington, L. I., New York.

Mar. 24-27—Institute of Radio Engineers, National Convention. Waldorf Astoria Hotel and New York Coliseum, New York City.

Mar. 24-29—Fourth International Instrument Short, Caxton Hall, London.

Mar. 30-Apr. 1—RFC-RNAS Reunion (World War I). Toronto, Canada. Contact: C. B. Stenning, Chairman, 149 South Drive, Toronto 5.

Apr. 8-10—Eighth International Symposia Electronic Waveguides, Microwave Research Institute of Polytechnic Institute of Brooklyn, Engineering Societies Bldg., 29 W. 39 St., New York City.

Apr. 16-19—14th Annual National Forum, American Helicopter Society, Sheraton-Park Hotel, Washington, D. C.

Apr. 17-18—Institute of Environmental Engineers Second Annual Technical Meeting, New Yorker Hotel, New York City.

Apr. 22-24—1958 Electronic Components Conference, Ambassador Hotel, Los Angeles, Calif.

Apr. 28-30—Second Annual Astronautics Conference sponsored by Air Force Office of Scientific Research and Institute of Aeronautical Sciences, Shirley Savoy Hotel, Denver, Colo.

May 4-7—Fourth National Flight Test Instrumentation Symposium, Park Sheraton Hotel, New York City.

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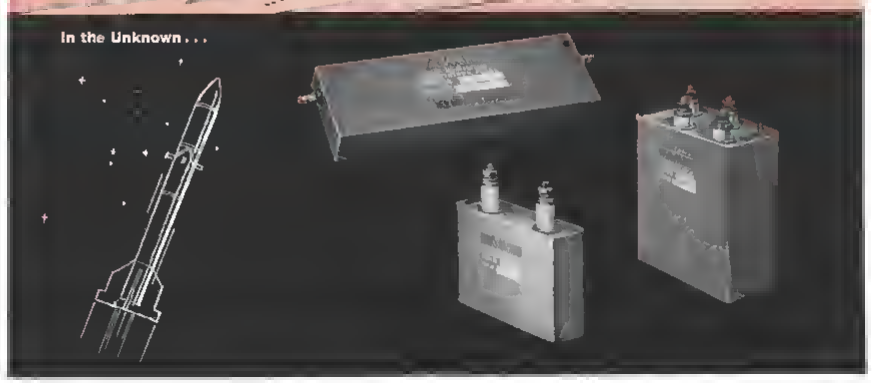

TPR is the nation's first completely mobile optical missile tracking system. Developed by Perkin-Elmer, the instrument is capable of photographing an object smaller than a baseball at more than 20,000 feet. The instrument records on film a missile's speed and altitude during its entire flight. Additional data can then be derived for aerodynamic analysis

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The "birds" hatched by the Air Force missile program fly fast—some moving at better than 10,000 miles an hour within seconds after takeoff. To track these experimental missiles in the field, Perkin-Elmer designed and built TPR (Telescopic Photographic Recorder)—a mobile 100 – 200 – 300 inch focal length tracking telescope synchronized with two sighting telescopes, a camera unit and a complex electronic control system, all mounted on a specially modified four-wheel gun mount.

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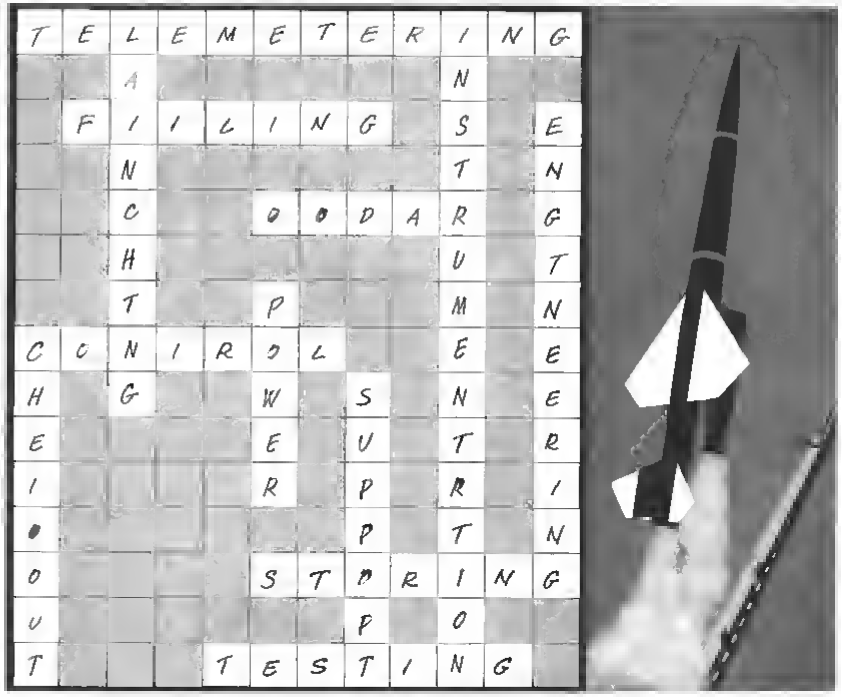

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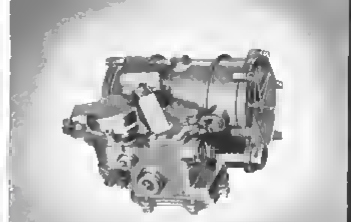
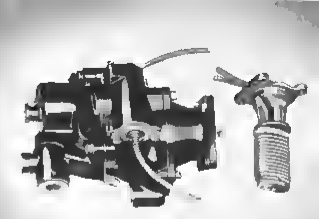


BLEED PISTON ACTUATOR



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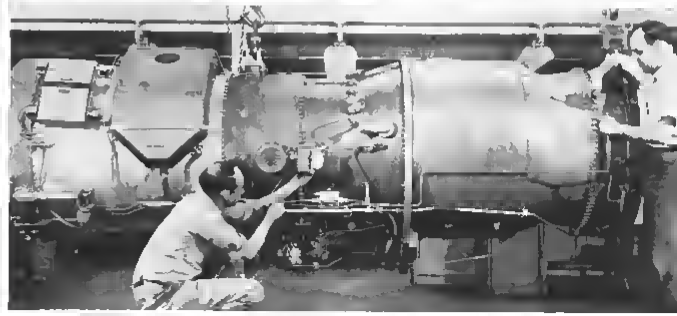

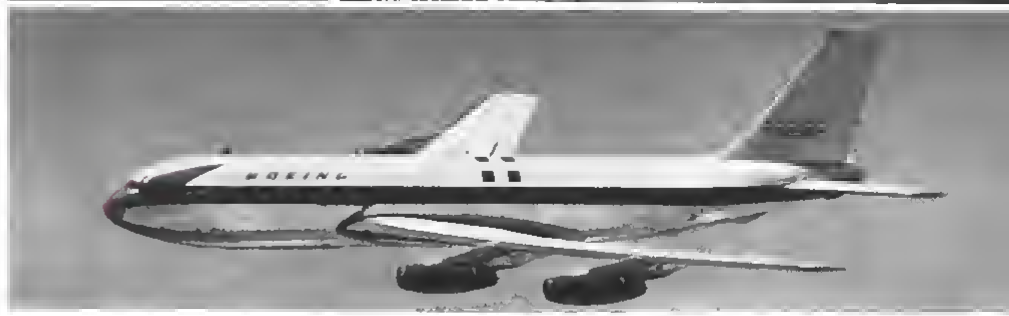

Powered by four JT4 Pratt & Whitney Aircraft engines, the Boeing 707-320 will carry 131 first class passengers from New York non-stop to the Continent in just over six hours! Each of these new engines, commercial counterparts to the J-75 which drives many of America's latest jet fighters, delivers up to 15,000 pounds of thrust. Ability to pack so much added power into a relatively small space is the result of designing engine components which will operate at higher efficiency, require less area and reduce over-all weight.

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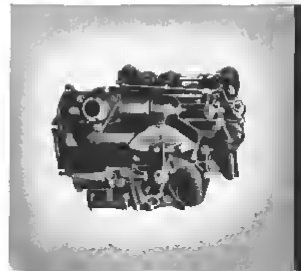

For military applications, the Holley main fuel control (right) is a companion unit to the governor and actuator.

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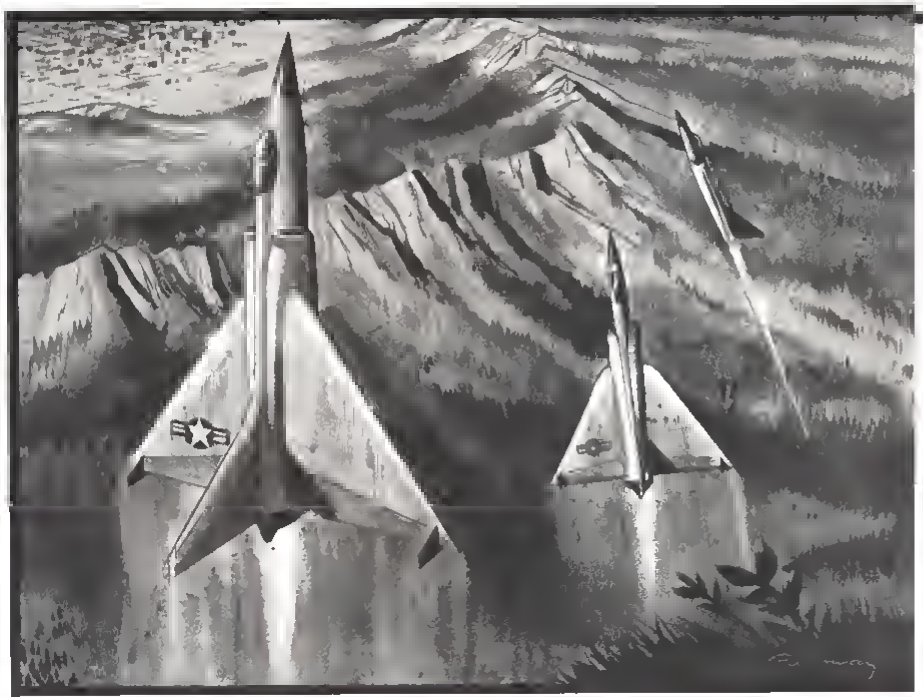

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January 20, 1958

AVIATION WEEK

Vol. 68, No. 3

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COVER First production Boeing 707-120 jet transport is designed to carry 124 first class passengers or 150 tourist passengers. Maximum payload is 42,700 lb. Aircraft is powered by four Pratt & Whitney JT3C-4 turbine engines, has a cruising speed of 591 mph. Boeing expects the 707 series to incur minimum direct costs, to achieve maximum reliability in all systems, to provide maximum maintainability and to permit maximum flexibility. For story and other photos about Boeing's 707 program, see p. 48

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AVIATION WEEK • January 20, 1958 • Vol. 68, No. 3
Member ABP and ABC

EDITORIAL

Why the Soviets Succeed

As the Sputnik inspired debates rise to full force on Capitol Hill and elsewhere as to just what the U S needs to surpass the Soviet Union technologically, it might be well to take a look at the past A fear inspired push to accelerate much needed defense programs only to be followed by an economy wave of complacency can do more harm than good What is needed is a calmly calculated, long-range program of acceleration in money, policy and determination

The main element in the Soviet success has been the determination and doggedness with which their program has been pressed on an extremely wide front—backed by high priority in manpower, technical education and development facilities It is this steady but not necessarily spectacular pace and broad scope of the Soviet Union effort in contrast to our brilliant but erratic spurts and long economy dictated slumps that accounts for the principal disparity between the results in the two countries

We have not yet learned the bitter lesson that these so-called economy waves are the most expensive indulgence we can find and, if not handled judiciously, they may eventually cost us our freedom and our country

The history of ballistic missile development in both countries is a case in point since both started from scratch at the end of World War II with only German V 2 experience as a guide The Soviets continued with the German line of development step by step—extending range, improving reliability and guidance The T 1 missile with about an 800 mile range was displayed last November in the Moscow military parade It showed little basic technical difference from the Peenemunde V 2 development, although its range had been tripled It was still using internal carbon vanes in the rocket exhaust for initial guidance and stability that were the hallmark of the V-2

In contrast, by 1947 Convair had successfully tested the MX 774A ballistic missile test vehicle that proved out major advances over the German V-2, including the use of swivel rockets for stability and control and integral fuel tanks using the missile skin as a fuel tank wall After several successful test firings of the MX 774 at White Sands Proving Ground, the program was virtually abandoned in 1948.

It is true that USAF was caught in the Louis Johnson budget squeeze, but it is also true that the Air Force made a fundamental technical decision that turned out to be wrong, it concentrated its development funds on the air breathing series, including Snark, Navaho and Bomarc, and left ballistic missiles for some future development

There is now an attempt to reconstruct the technical history of that period and assign the abandonment of a promising ballistic missile development to the fact that thermonuclear warheads then looked too large for a ballistic vehicle But it is interesting to note that this fact did not slow or stop the Soviet development, and they continued developing the high thrust rocket powerplants necessary to move the old style, heavy thermonuclear warhead across the Arctic to U S targets And these high thrust rockets later proved exceedingly useful in lifting the heavy Sputniks into their orbits around the Earth

In 1954, after the small thermonuclear package was developed, U S ballistic missile development was revived on a crash basis and has made excellent progress since then But the net result has been to put us at least a year behind in the operational use of the intermediate range ballistic missile and in a neck-and-neck race in the intercontinental range area This is a race we should have won hands down in the early 1950s Instead of being whipsawed by the Soviets in an international ballistic missile blackmail game, we would now have these weapons fully operational as another evidence of continuing, clear military superiority

Another interesting area in which a difference in policy approach has produced different technical results is the field of propulsion Until recently in this country, we tagged powerplant development to a specific aircraft or missile project, and you don't have to travel far to hear our engine makers complain that this artificially restricted their technical development capability

In Russia, propulsion was cut loose from airframe development and allowed to push its own state of the art at the fastest pace its technical resources would allow As a result, the Soviets have consistently come up with more powerful engines in every category well before we have In the turbojet class, they had a 19,000 lb thrust turbojet operational in 1954, and we are not yet in that class without afterburning Similarly, they had a 12,000 eshp turboprop engine operational in the same year, and we abandoned advanced development of our only project in this class two years later when it still had not powered an aircraft in flight

In the rocket field, their 825,000 lb thrust unit is running on the test stand, but U S rocket maker's pleas to tackle a million pound thrust unit have fallen on deaf Defense Department ears according to recent testimony of Army and Air Force missile men before the Johnson Subcommittee

This surplus of power has given Soviet airframe and missile designers an advantage their U S contemporaries do not enjoy No one-shot budget push or timorous planning is going to rectify this.

—Robert Hotz

WHO'S WHERE

In the Front Office

Warren Lee Pierson, board chairman of Trans World Airlines, Inc., has been named acting president of the line following the resignation of Carter L. Burgess.

Pan American World Airways Inc. has appointed **J. G. O'Donnell** and **John Oppenheimer** directors of the Pacific Alaska Division, Mr. O'Donnell director for Hong Kong, China, Thailand and Burma and Mr. Oppenheimer, director for the Southwest Pacific.

Theodore F. Talmage, vice president administration, Perkin Elmer Corp., Norwalk, Conn.

Henry A. Correa, vice president for foreign operations, ACF Industries Inc., New York, N. Y.

J. G. Helvey, vice president and general manager, Aaxico Airlines Inc. **Joseph A. Young** succeeds Mr. Helvey as vice president operations.

William L. Dunn, vice president and director of engineering, Admiral Corp., Chicago, Ill.

Rear Adm. **Adrian H. Perry** (ret.), chief foreign representative and **Capt. Chester A. Briggs**, (USN ret.), chief of research and development, Chance Vought Aircraft Inc., Dallas, Tex. Mr. Perry will be located in Washington, D. C.

Dr. Winston E. Kock, general manager, Research Laboratories Division, Bendix Aviation Corp., Detroit, Mich. Also, **Charles Edwards**, assistant director-technical activities and **Dr. Gerald A. Rosselot**, assistant director-administration.

Curt F. Fineham, assistant to the president, Canadair Limited, Montreal, Canada. Also, **H. G. Sager**, Canadair's Ottawa representative.

Honors and Elections

Mundy I. Peale, president of Republic Aviation Corp., has been named sponsor of the sixth annual Aeronautic Production Forum of the Society of Automotive Engineers, Inc., New York, N. Y. **Kermit F. Wasmuth**, Republic's director of quality control, has been named chairman of the forum.

Robert J. Shank, vice president-engineering of Hughes Aircraft Co., and **Dr. Harold Lyons**, head of atomic and molecular physics for Hughes, have been named Fellows of the Institute of Radio Engineers. Mr. Shank was named for his "contributions to airborne military electronics," and Dr. Lyons for his contribution to development of atomic frequency standards.

Changes

Aubrey Keif, director-Aviation Sales Department, the Texas Co., New York, N. Y.

Miss Betty Cates, assistant vice president, Overseas National Airways.

W. R. Barnes, components marketing manager, Grand Rapids Division, Lear, Inc.–Grand Rapids, Mich.

Edward J. Chevins, sales engineer, Mech-

(Continued on p. 103)

INDUSTRY OBSERVER

► Decoys and other methods of radar deception will aid the Martin Co.'s Titan intercontinental ballistic missile in penetrating anti-missile-missile defenses. Techniques would saturate or confuse defending radars and computers. Russia has an intensive anti-missile-missile program under way and may have parts of its system operational shortly after U. S. ICBMs become operational.

► Look for more sophisticated and streamlined solutions to nose cone re-entry problems. Present blunted designs, while bringing an ICBM warhead safely back into the atmosphere, slow the speed of re-entry to a point unsatisfactory to missile men, particularly in light of the Soviets' accelerated anti-missile-missile development.

► NATO commander Gen. Lauris Norstad has asked for 20 intermediate range ballistic missiles for Western Europe. No specific bases for the squadrons have been mentioned, but several existing facilities could be adapted or mobile launching sites used.

► Cost of Navy's first nuclear powered missile submarine specifically designed to carry the Polaris fleet ballistic missile is expected to run between $105 million and $110 million. Cost of the second and third Polaris submarines should drop to approximately $85 million.

► Defense Department will spend more than $1.6 billion during Fiscal 1959 on the Atlas, Titan, Thor, Jupiter and Polaris ballistic missile programs. About half of this will be for electronic components. The total ballistic missile figure also represents approximately half the funds Defense plans to spend on missiles in Fiscal '59.

► Atomic Energy Commission plans to begin ground testing of its Rover nuclear powered rocket project later this year. Test facilities for the ground testing are now under construction by AEC in Nevada.

► Czechoslovakia plans to manufacture the two place HC-2 light helicopter (AW Nov. 11, p. 109) for use as a trainer, air taxi, litter bearer and mail carrier and for agricultural uses. Designer Jaroslav Sleichta says tests show that the HC-2 cruises at 62.1 mph., has a fuel consumption of approximately 5.8 gal. per hour.

► Representatives of International Assn. of Machinists and United Auto Workers, AFL-CIO, plan to present a joint front in forthcoming negotiations with the aircraft industry in Southern California. Major objectives of the two unions, which represent some 200,000 aircraft workers in the area, include a union shop, severance pay, relocation and transfer allowance, apprentice training programs, improved wage structure and health insurance.

► Proposal that salaries of government scientific personnel be boosted to a level approximately equal to those paid in non-government jobs in the same category will be submitted to Dr. James R. Killian, Jr., special presidential assistant for science and technology, by a group of senior civilian scientists attached to military research laboratories in the New England area. Proposal will be urged as necessary to keep highly qualified scientific manpower in government positions. It also will call for an annual review and adjustment of salaries by the Civil Service Commission without the need of congressional approval.

► Hungary's aviation industry—sharply curtailed by the 1956 revolt—is showing new signs of life in the sports field although it still lags far behind other Soviet satellites such as Czechoslovakia, East Germany and Poland. Latest development at Hungary's Alag aviation facility is a prototype of an all-metal glider with a 41 ft. wing span, 19.3 ft. length and a V-shaped tail assembly.

► Air Force's Wizard and Army's Nike-Zeus anti-missile systems have projected kill probabilities of only about 25% against enemy intercontinental ballistic missiles based on the present state of the art.

Washington Roundup

Sputnik Effects

Here is the degree to which the defense budget was affected by pre-Sputnik economies and post-Sputnik politics:

First estimates of the services had to fit within guidelines" of $38 billion for obligations and $38 billion for expenditures. Defense Department then cut out "unbalances," or unessential items. This brought the total down to some $36 billion.

Defense, the services, the President and the National Security Council then discussed—in a post-Sputnik atmosphere—the essential 'add-ons' which would not fit under the original ceilings. This brought the total back above $40 billion.

Political and public pressure for immediate action, coupled with the Administration's desire to balance the budget if at all possible, led to a plan which amounts to taking double credit for the $1.26 billion Fiscal 1958 supplements defense request.

By cutting the "add-ons" out of the Fiscal 1959 budget and shifting them into a supplemental request, Administration came closer to balancing both budgets, took credit for acting with alacrity and is saying now that the Fiscal 1959 budget is really much bigger than it looks because the $1.26 billion supplemental actually can be thought of as a part of the plans for that year.

Budget Flexibility

New defense budget, however, provides more flexibility for taking immediate advantage of technological advances than any previous budget. It also gives President Eisenhower more control over activities of the services.

In addition to the request for $2 billion defense transfer authority (see p. 28) the President asks for a $500 million defense contingency reserve fund that would allow him to "modify and accelerate programs when and as important discoveries or technological developments in weapons indicate such action to be desirable."

Office of Secretary of Defense also asks an emergency fund for research, development, test and evaluation totaling $85 million to "defray the costs of preliminary exploration of new developments and other such contingencies." While this fund is not new this year, pressure of international affairs and national politics would indicate that it is more likely to be used than before.

Research Reserve Fund

Rep. William Dawson (D-Ill.), chairman of the House Government Operations Committee, wants a $200 million Scientific Research Reserve Fund established to finance selected scientific basic and applied research projects without the lengthy delay involved in securing the approval of and appropriations for such projects.

A staff study of the budgeting and organization of government research agencies shows that one of the serious problems is the lag between the time when an important research project is conceived and the time it can actually be commenced. Dawson said: "In many cases various types of government red tape result in a two to ten year lag. A similar problem arises when a research project approaches a 'breakthrough' stage but money is not available to push it through or when the continuity of an important project is otherwise threatened because of lack of funds."

Vinson: Quiet Defense Study

House Armed Services Committee under the chairmanship of veteran Rep. Carl Vinson (D-Ga.) is quietly proceeding with a major investigation of the defense program, while the public hearings of Sen. Landon Johnson's (D-Tex.) Senate Preparedness Subcommittee are taking the headlines. The House hearings, which will last about five weeks, will be in two phases: (1) space projects and missiles and (2) manpower, adequacy of the budget, organization into combat and support units and adequacy of their weapons, roles and missions of the three services, and organization and operation of the Joint Chiefs of Staff.

Key to Space

Key to the nation's penetration of space frontiers is decisions now—not new agencies—Aircraft Industries Assn. President Orval Cook told an Institute of Aeronautical Sciences audience last week.

National Advisory Committee for Aeronautics "has been conducting research and studies in scientific fields leading to man's conquest of space" for more than 10 years, Cook said, and it can provide direction of space efforts if a governmental agency is needed.

Cook said the government's "unusual fiscal dilemma" in the past year cost the aircraft industry time, ordered progress and an estimated 100,000 workers and brought the stocks of 12 major airframe companies down at the beginning of this year by 30% from their 1957 high. He urged an end to frequent and rapid expansion and construction of the industry, and said the nation must "make maximum use of our existing organizations, expand them where necessary, give them the authority and direction and get on with the job."

Apathy Towards Labor

"Government's indifference and industry's apathy with respect to skilled labor" is costing the nation vital time, a permanent loss of skills and "millions upon millions of tax dollars for the recruitment and restraining of new workers to take the place of those who have been so casually dropped during the past year," the head of the biggest aircraft workers' union believes.

A. J. Hayes, president of the International Assn. of Machinists, says professional and academic talents of scientists and engineers are "an exercise in futility" without skilled production workers to translate ideas into hardware. Some 70,000 dismissed in the past year.

Search Ends

Year's search by State Department for a special science adviser to Secretary John Foster Dulles came to an end last week with the appointment of Dr. Wallace R. Brode, who leaves his post as associate director of the National Bureau of Standards. State, without a science adviser since 1953, began an active search for a new one more than a year ago but found that many scientists were unwilling to take the job (AW Nov. 18, p. 25).

—Washington staff

USAF Plans Moon Strike Within Months

Payload to Moon to be tried with Thor, two stages of Vanguard; Redstone to explore nuclear blasts.

Washington—USAF will attempt to send a payload to the Moon, probably within the next few months, using a Douglas Thor plus second and third stages of the Martin Vanguard, AVIATION WEEK has learned. A total of 18 Thors will be diverted from the missile program for space research projects.

Diversion of the Thors apparently accounts for USAF's passing an out-of-atmosphere nuclear explosion program over to Army. Using four Redstone missiles, Army this summer will fire nuclear devices to 250,000 ft. and above from Atomic Energy Commission's Eniwetok test grounds.

Meanwhile, Maj. Gen. Bernard A. Schriever told the Senate Preparedness Subcommittee that USAF expects to put a recoverable reconnaissance satellite into orbit by the spring of 1959, using the Thor as a booster. Schriever is head of the Air Research and Development Command's Ballistic Missile Division.

Target Date

First target date for the Moon shot—April of this year—was abandoned because of uncertainty over USAF's intentions and funding. No contract exists yet, but Douglas has been studying use of Thor for space programs for some time.

Twenty top experts from the Ballistic Missile Division are working in the Douglas plant now in connection with use of Thors for space research.

Rand Corp., which has done a number of space studies for USAF, has given strong backing to use of Thor for a Moon shot. Payload would either impact or orbit.

Although Vanguard second and third stages are leading contenders now due to payload capability, Lockheed X-17 second and third stages still are in the running due to reliability of their solid propellant motors.

Nuclear Firings

Purpose of the Redstone-nuclear firings will be to gain basic data on detonations beyond the atmosphere, where lack of air would eliminate blast effect and modify radiation effects, and to gain operational weapon performance data.

First shot will be detonated at 250,000 ft. Additional shots will be fired at successively higher altitudes.

In his testimony before the subcommittee, Gen. Schriever outlined other astronautics programs that could be started immediately. Schriever also said twice the number of Thor, Atlas and Titan squadrons can be equipped within the same time period if decisions are made immediately and full financial support is provided.

Doubling the rate of equipping and deploying missile squadrons would require "relatively small increases" in Fiscal 1958 funds but "considerable additional funds over those presently budgeted for Fiscal 1959," Schriever said.

Schriever told the subcommittee these space programs could be begun now "without dilution or diversion" of the missile program.

- "Our present Thor missile with existing second stage hardware can place a satellite in orbit with a respectable payload." This apparently refers to the recoverable reconnaissance satellite, which could serve as a test vehicle for the later, larger Lockheed Pied Piper reconnaissance vehicle. It is to be boosted by the Convair Atlas.
- "By adding existing third stage hardware, this vehicle can perform unmanned reconnaissance of the Moon at a relatively early date." This apparently is a reference to the Thor-Vanguard Moon vehicle.
- "Slightly modified Thor plus a high energy fuel stage which we have been developing can make possible initial unmanned reconnaissance of Mars and Venus."
- "The (Martin) Titan booster when developed, plus high-energy second and third stages, could put much greater weights into orbit and could provide extended manned satellite missions. This vehicle could provide manned flight around the Moon and back to Earth."

"It would be a colossal blunder" not to plan for later generations of ballistic missiles; and the challenge of astronautics—even though its military requirements are not yet as clear—demands just as immediate and vigorous a program to surpass Soviet efforts, Schriever said.

Air Force already has made "the original investment for preliminary projects in space flight," Schriever said. In an apparent reference to the Advanced Research Projects Agency (see page 28) which he opposed in earlier testimony, Schriever said:

"I believe that any program to develop a separate astronautics agency would result in duplication of the capabilities already existing in the Air Force ballistic missile programs, and at a cost in funds and time similar to that already expended on these programs."

Schriever said USAF already has provided for some $500 million in new ballistic missile development, test and production facilities that did not exist even three years ago. He said USAF already has a "vast military, scientific and industrial organization engaged in missile work and said its personnel "have mastered many new fields of knowledge which can be springboards to substantial short cuts in our masters of astronautics."

USAF has received approximately 250 proposals for Moon shots and space travel from a great number of individuals and companies in the past few months. It also planned to create a Directorate of Astronautics within the office of Deputy Chief of Staff for Development, but the Defense Department forced it to withhold its plans at least temporarily.

Degree to which USAF's Air Research and Development Command has attempted to accelerate long-planned space research since Sputnik made it acceptable is indicated by the fact that some proposals are being made directly to Maj. Gen. John W. Sessums, Jr., vice commander of ARDC.

One of these is the recent proposal by Aeronutronic Systems, Inc. for a lunar follow-up of its Project Farside (AW Dec. 16, p. 26). Program could be completed within about one year unless higher priority were assigned.

Other proposals call for use of boosters and engines ranging from the Atlas, Titan and Thor down to Thiokol Sergeants and Aerojet-General Jupiter Sciors (AW Nov. 4, p. 27).

In addition to satellite and space vehicles, USAF has five proposals for hypersonic glide bombers—from Bell Aircraft Corp., North American Aviation, Inc., Republic Aviation Corp., Martin Co. and Boeing Airplane Co. Unless funds for hypersonic glider work are included in the Fiscal 1958 budget, none of the projects will have gone past the study stage.

Contract for MA-1

Hughes Aircraft has received a $21,188,717 contract for production of the MA-1 automatic flight and fire control systems for the Convair F-106. Contract boosts total expenditures for this system to more than $120 million.

Primary parts of the system are the data link, which converts ground-transmitted command signals into actual aircraft maneuvers until the plane's own radar locks onto target and takes over command for the attack and weapons delivery, and the "Digitar" airborne digital computer.

MA-1 is capable of operating the aircraft through entire mission profile after pilot has taken off, could conceivably even effect landing through the touchdown phase.

Hughes also has been awarded a contract for $19,278,275 for production of the GAR-3 and GAR-4 at the company's Tucson plant. The 3 and 4 designations refer to new longer range versions of both radar-guided and infrared guided Falcon missiles.

New engines are incorporated in the new dash number missiles.

Fairchild Drops M-185 Jet Business Transport

Hagerstown, Md.—Four-jet eight-passenger M-185 executive transport project has been shelved by Fairchild Engine & Airplane Corp.'s Aircraft Division Company said this will allow the company to concentrate on production and sales of the F-27 Friendship turboprop-powered transport.

Firm only had five options to purchase M-185s on its books, although the airplane was initially announced in the summer of 1956 (AW Sept. 3, 1956, p. 100). It estimated then that it would require approximately 100 orders to break even on production basis. Deposits have been returned to the three corporations which indicated a desire to purchase the airplane.

Need for increased effort on the more lucrative F-27 was emphasized as a reason for dropping the M-185. Fokker-designed turboprop transport has been a major factor in maintaining stable employment level in the Aircraft Division, 2,500 of the approximately 7,500 people employed at the Aircraft Division are now on the F-27. Firm has 84 orders for this plane, 22 of which are short term options, 14 companies have ordered F-27s for executive travel.

New Atlas Photos Show Vernier Engines

New pictures of the Atlas from fourth and latest firing reveal additional details of missile configuration. Clearly shown (above, right) are the small secondary exhausts which angle out above the main exhausts. These are from the missile's Vernier engines. Protruding from the bottom of the missile are the nozzles from the two booster engines set on opposite sides of the Atlas.

More Procurement Funds Go to Defense

Supplemental requests, 1959 budget will increase defense contracting by 76% in next six months.

By Evert Clark

Washington—Defense contracting in the next six months will be 76% higher than in the past six months and contracting in the last half of calendar 1958 will be almost a third higher than in the last half of 1957, pushing the defense total to its highest since the Korean war

Relaxation of controls on Fiscal 1958 spending—rather than the $39 779 billion expenditures expected under the Fiscal 1959 budget—accounts for most of the immediate impact on the aviation industry

Fund Obligation

In addition to accelerated contracting with 1958 funds, Defense Department expects to obligate 80% of its requested $1 26 billion supplemental 1958 appropriation by next June 30

President Eisenhower asked Congress for $39 145 billion in new obligational authority for the Defense Department in Fiscal 1959 An additional $345 million is available in transfers from unobligated balances, making the effective obligational authority for next year $39 49 billion.

This includes requests for authority to contract for $5 866 billion in aircraft and $3 836 billion in missiles continuing the shift in emphasis to missiles over manned aircraft The missile figure is $1 544 billion higher than the 1958 figure, even including the 1958 supplemental

Expenditures for aircraft in Fiscal 1959 are estimated at $6 904 billion—down $615 million from 1958—and expenditures for missiles are estimated at $3 314 billion, an increase of $397 million from the previous fiscal year

Explanation of the large increase in spending due the January-June half of 1958 lies in the extreme slowdown in defense procurement during the past six months coupled with the present acceleration

Total Procurement

Total procurement, which ran $9 9 billion from January through June, 1957 was held down to $7 6 billion in the last half of calendar 1957

In the first half of calendar 1958, it will jump to $13 4 billion In the last half of the calendar year, which corresponds to the first half of Fiscal 1959, it will continue at a rate of $9 8 billion—almost back to the normal pre-fiscal 1958 level

Total procurement therefore, will be $23 2 billion for calendar 1958, the highest post-Korean total, and $5 7 billion higher than in calendar 1957 The includes major procurement of aircraft, missiles, ships etc, and other types of contract work such as maintenance, research and development and military construction

Areas to be accelerated under the supplemental 1958 request and the Fiscal 1959 budget include

- **Ballistic missiles** Supplemental request includes $683 million Fiscal 1959 request includes twice the figure asked in the original 1958 budget The 1959 request is also "substantially greater" than the original 1958 request plus the supplemental, Defense fiscal officials say In spite of the increase, USAF chiefs have testified that the Atlas, Titan and Thor ballistic missiles have not been accelerated enough
- **Strategic Air Command** alert and disperal Supplemental request includes $219 million, and Fiscal 1959 budget includes approximately that much more. President Eisenhower said in his budget message to Congress last week that the total for the two years will run "about $0 5 billion" Bulk of this is for bases First production funds for the Convair B-58 supersonic bomber are included in the Fiscal 1959 budget, but it contains no new funds for production of Boeing B 52 Stratojets
- **Ballistic missile detection.** First budget money to appear for this work is contained in the Fiscal 1958 supplemental bill—$329 million Fiscal 1959 budget calls for approximately $320 million About half of the supplemental money will go for construction This work remains under Air Force direction, although work on the anti-missile missile itself has been transferred to Defense's new Advanced Research Projects Agency (see box at left)
- **Satellite and space projects** Advanced Research Projects Agency takes over this work, asking $10 million in the supplemental request and $340 million for Fiscal 1959 (see box at left)
- **Anti-submarine warfare** Original amount planned late last summer for the Fiscal 1959 budget has been increased by $250 million
- **Military and civilian pay** increases to implement Cordiner Committee recommendations The supplemental request includes $219 million in military funds funds for civilian increases will be handled outside Defense Department

In presenting his budget to the Congress President Eisenhower said increased defense spending and decreased receipts will result in an estimated budget deficit of $0 4 billion for Fiscal 1958

He expects a half billion dollar surplus in Fiscal 1959 but said he will recommend raising the $275 million debt ceiling, maintaining present tax levels, extending the Renegotiation Act and the Defense Production Act, raising patent fees and tightening "operating and fiscal controls"

The President said "the progress of the Soviets in long range missiles and other offensive weapons together with their continuing rejection of a workable disarmament, compels an accelerated defense effort The defense portion of the budget said recent demonstrations of Soviet scientific progress have pointed up some areas which should now receive still greater emphasis"

The President also asked Congress for authority to transfer up to $2 billion between military appropriations to allow him to modify and accelerate programs on short notice if new discoveries and developments indicate shifts are desirable from already programmed items to other weapons that show a demonstrated superiority" Fiscal officials said the intention is to transfer between appropriations within a service, and not between services

Defense this year is asking for $2 256 billion for research and development an increase of $495 million Basic research, running at about $80 million under the 1958 budget, will be increased about 50% Total for research, development test and evaluation, which uses some procurement and production money will continue at about $5 billion

USAF's research and development obligations continue at $730 million Navy's rises from $549 million to $641 million and Army's rises from $444 to $471 One reason for the steady USAF figure and the small Army increase is that anti-missile funds were removed from these two services and put into Advanced Research Projects Agency

Electronics and communications obligations for Defense Department continue their steady upward trend, rising 34% over 1958, from $703 million to $1 071 million USAF's electronics obligations figure rises from $557 million to $770 million in Fiscal 1959 Navy's

ARPA Gets Pied Piper

Washington—Advanced Research Projects Agency expects to spend $199 million in Fiscal 1959 on anti-missile missiles and space projects.

Specific programs to be directed and founded by ARPA after Fiscal 1958 include Air Force's Pied Piper reconnaissance satellite project (WS-117L).

Total budget requested for ARPA for Fiscal 1959 is $340 million Another $10 million has been requested as a supplemental Fiscal 1958 appropriation

More than half of the 1959 expenditures will be for anti-missile work Obligations will be about evenly divided between anti-missiles and the general category of "satellites and other space vehicle systems and other advanced programs."

Scope of ARPA's operation still is not well defined, but projects not so clearly in the outer space category—such as the North American X 15 rocket research plane and hypersonic boost-glide aircraft—apparently will remain under Air Force direction

Also still undefined is the degree to which ARPA will take control of its projects Services will continue to do the work but under ARPA's direction

Ballistic missile detection, for example, remains in the Air Force program for the time being although the anti-missile itself is under ARPA.

Administration's budget document states that ARPA's activities "may include studies, research, component and system development, testing construction of facilities and necessary land acquisition, and other such activities as may be determined by the Secretary of Defense"

Although ARPA will administer this work "implementation of specified projects may be assigned to a military department to utilize, on a reimbursable basis or otherwise, specialized competence or facilities which may be available."

President Eisenhower's request for the $10 million supplemental 1958 appropriation for ARPA calls for 15 professional and scientific positions and 10 other 'super grade' Civil Service positions in grades 16, 17 and 18

Major Expenditures-Obligations*

(In millions)

	Expenditures FY 1959 (Est.)	Expenditures FY 1958 (Est.)	Expenditures FY 1957 (Actual)	New Obligations FY 1959 (Est.)	New Obligations FY 1958 (Est.)	Availability FY 1957 (Actual)
AIR FORCE						
Aircraft	4,970	5,410	5,817	3,991	4 223	4,821
Missiles	2,112	1,970	1,417	2,704	1,890	1,970
Electronics & Communications	634	574	545	770	557	410
Production Equipment & Facilities	234	302	245	120	300	334
Research & Development	730	730	729	719	686	724
Operation & Maintenance	4,077	3,987	4,095	4,109	4,047	3,745
NAVY						
Aircraft	1 830	1,935	1,996	1,739	1,536	1,483
Missiles	446	321	264	612	482	352
Electronics & Communications	160	156	119	108	145	189
Production Equipment & Facilities	50	76	68	23	32	64
Research & Development	605	573	523	641	549	542
Operation & Maintenance	2,507	2,485	2,475	2,489	2,532	2,406
ARMY						
Aircraft	184	178	186	136		
Missiles	756	626	414	519		
Electronics & Communications	78	109	216	193		
Production Equipment & Facilities	86	173	150	118		
Research & Development	480	450	435	471	444	433
Operations & Maintenance	2,707	2 869	2,643	2,723	2 834	2,795

* FY 1958 figures include supplemental budget requests.

Airpower Program

	Actual End FY 1955	Actual End FY 1956	Actual End FY 1957	Planned End FY 1958	Planned End FY 1959
AIR FORCE					
Wings	121	131	137	117	105*
Active Aircraft Inventory	23,694	26,760	25,969	22,057	20,843
NAVY					
Carrier Air Groups	17	17	17	17	16
Carrier Anti-submarine Squadrons	19	19	20	20	20
Marine Aircraft Wings	3	3	3	3	3
Active Aircraft Inventory	12,821	12,317	11,617	10,654	9,826
ARMY					
Antiaircraft Battalions	122	133	119	88	86†
Active Aircraft Inventory	3,539	3,573	4,447	4,937	5,439‡

* Strategic 43, air defense 27 tactical 35
† Includes 73 missile battalions.
‡ Includes 2,443 helicopters.

drops from $145 to $108 million, but Army's rises from nothing last year to $193 million this year.

Other highlights

• **USAF is asking** for a total budget of $18 044 billion, compared to the $17 739 billion final estimate for Fiscal 1958. At the end of Fiscal 1959, it will have 850,000 personnel and 105 wings —down 23 wings from the 128 wing level forecast a year ago. This decrease is partly explained by transfer of four heavy troop carrier wings from Tactical Air Command to Military Air Transport Service, reorganization of Air Defense Command, which consolidated some wings, loss of some TAC reconnaissance aircraft and medium bombers as Army increases its tactical missile capability.

Mace, a longer range, low-level tactical version of the TM 61B Matador, will be added to the inventory as will Thor and Jupiter intermediate missiles. Active aircraft inventory will decrease by 1,214 from a Fiscal 1958 total of 22,057 to 20,843.

• **Navy is asking** $10.72 billion, compared to $10 469 billion last year. Navy will have 630,000 personnel, 864 active ships, and 9,826 active aircraft—down from 10,654 the previous year. Aircraft include 16 air groups and 20 carrier anti-submarine squadrons, and three Marine air wings. Navy has funds for feasibility studies for a nuclear aircraft (AW Jan. 13, p. 33) but apparently has not yet received approval to go ahead on it.

• **Army is asking** $9 036 billion. At the end of the fiscal year, its strength will be 870,000 men, including 73 missile battalions and four missile commands. Active aircraft will total 5,439 and include 2,996 fixed wing and 2,443 helicopters.

$106.7 Million Asked for NACA

Washington—Congress was asked by President Eisenhower to appropriate $106.7 million for National Advisory Committee for Aeronautics Fiscal 1959 research and development activities. He also asked a supplemental appropriation of $11,780,000 for 1958.

The Fiscal 1959 budget estimate is $700,000 more than Congress appropriated for 1958 and $11.5 million less than NACA asked for the current fiscal year. But, with the supplemental appropriation for 1958, the 1959 budget request is still more than $11 million below the 1958 total.

Expanded Research

The biggest cutback for Fiscal 1959 was in construction and equipment. For the next fiscal year, $26,220,000 is being requested as compared with $35 million appropriated by Congress last year. Operating expenses were increased to $80 430,000 as compared with $71 million appropriated for the present year.

The President said supplemental funds were requested for Fiscal 1958 to permit immediate expansion of the committee's research operations to meet the increasingly complex problems of flight under a wide range of conditions.

During congressional hearings on appropriations last year, NACA Chairman James H. Doolittle warned that Russia had closed the technological gap between Russia and the U. S. and that the Soviets already had more airplanes and more scientists and engineers than the U. S.

NACA said during the hearings that it had requested a Fiscal 1958 budget of $147,778,000, including an operating budget of $86,760,000 and construction budget of $61,018,000, but that it was not approved by the Bureau of the Budget. This was to have provided for a 25% increase in NACA's efforts to meet the Soviet challenge.

A breakdown of the construction and equipment budget for 1959 follows:

Langley

Langley Aeronautical Laboratory, Langley, Va., has asked for $12,870,000 in Fiscal 1959 and an additional $6,780,000 for 1958 under a supplemental appropriation. The 1959 estimate would provide for construction of a major new facility for high temperature research on structures and for utility improvements.

The 1958 supplemental appropriation for Langley will provide:

• **Data reduction center**—$3,067,000. NACA last year asked for authority to build this facility but did not request funds.

• **Instrumentation of a dynamic systems** research aircraft—$1,040,000. This would provide installation of airborne instrumentation in a supersonic aircraft and matching ground instrumentation and support equipment to permit flight studies of various dynamic systems such as those used in high performance aircraft and missiles for flight control guidance and weapons aiming.

• **Ultra high temperature** materials facility. This would include equipment for an arc jet to heat temperatures from 5,000 to 20,000 degrees and data recording equipment to simulate air dynamic conditions during atmospheric entry of long-range ballistic missiles.

Ames

Ames Aeronautical Laboratories, Moffett Field, Calif., is seeking authorization for two new hypersonic research facilities and modifications to an existing facility. Total asked is $4,321,000. The projects:

• **A 12x12 in. hypersonic helium tunnel.** This facility would cover a Mach range from 12 to 20 and permit studies of hypersonic flow phenomenon in sufficient detail. NACA hopes to remove many uncertainties in the art of hypersonic aircraft design.

• **Hypervelocity research laboratory.** This would include a shock tube ionized gas tunnel and gas mixture channel plus supporting equipment and instrumentation. It would be used to study basic properties of high temperature gases, effects on properties and physical and chemical interactions between such gases and other materials. Purpose is to provide a better understanding of atmospheric effects during operation of very high speed aircraft and missiles.

• **Modifications to the flight research laboratory.** A two story addition to the existing facility would house an electronic simulator and other equipment used to study vehicle control problems at high speed.

Lewis

Lewis Flight Propulsion Laboratory, Cleveland, Ohio, is asking $8,892,000 for two new facilities and modifications to existing facilities. They are:

• **High energy rocket** research facility. This would include three test cells, control room and equipment for the study of high pressure propellents.

• **Hypersonic missile propulsion facility.** The facility would include a laboratory building, hypersonic tunnel to permit temperatures up to 4,000F., a hypersonic shock tube and arc jet to study effects caused by highly disassociated and ionized air at temperatures of up to 20,000F and a low density propulsion research facility to study low thrust propulsion systems for use at altitudes of up to 60 mi.

• **Modifications to existing facilities,** including a new wing to the material research laboratory for research on meteorological and ceramic materials for advanced nuclear and chemical powerplants for aircraft missiles and space vehicles, installation of a 10 x 10 ft. tunnel to study effects of increased air temperatures at high speeds and high altitudes and modification of another wind tunnel for research on rocket control systems.

Wallops Island

Pilotless Aircraft Research Station at Wallops Island, Va., is asking $137,000 for erosion control in the area.

National Advisory Committee for Aeronautics

(In millions)

	FY 1957 (Actual)	FY 1958* (Actual)	FY 1959 (Est.)
General Operating Expenses	$64.1	$71	$80.4
Construction	14	35	26.2
Langley	7.4	5.7	12.9
Ames	.9	11.3	4.3
Lewis	5.7	16.4	8.9
Pilotless Aircraft Station	.....	1.6	.3

* Does not include proposed supplemental request.

Congress Gears for Budget Fight

By Katherine Johnsen

Washington—Initial congressional reactions to the President's budget message last week pointed to the many facets the Hill debate over the Fiscal 1959 defense budget will take. Out look, however, is that the President's figure will be raised.

All sides volunteered that "all funds necessary" to meet Russia's challenge in military power and technology will be provided.

Rep. George Mahon (D.-Tex.), chairman of the House Appropriations Subcommittee on the Armed Services that has been conducting hearings on the $1.2 billion additional defense request for Fiscal 1958 (AW Jan. 13, p. 31), viewed the Administration's program for missiles and "weapons of the future" as "conservative." He suggested that increases in certain highly critical areas such as ballistic missiles may be necessary. But Mahon, as well as other members, qualified his statement by saying the situation should not be prejudged until extensive hearings have been made clear.

Charge by Jackson

Sen. Henry Jackson (D. Wash.) criticized that Department of Defense killed an Air Force request of several hundred million dollars for additional B-52s, KC-135 tankers and B-58 bombers in the Fiscal 1959 program. "This sort of action certainly does not seem to be a fulfillment of that portion of the President's address in which he emphasized the present and immediately foreseeable need for increasing our air power in terms of the most advanced planes available," Jackson said. "It is one thing to say the proper things and quite another to do the proper things."

Sen. Leverett Saltonstall (R.-Mass.) countered:

"The President intends to maintain the retaliatory strength of B-52s and B-58s as they come along and even after missiles become reliably operational the SAC bombers will be one of our strong arms of defense.

"No department of government gets all the money that it wants. But President Eisenhower in his State of the Union message, amplified by his budget requests, clearly indicates his intention to insure this country's security, to maintain and constantly strengthen our defensive power."

Sen. Stuart Symington (D.-Mo.) said he is apprehensive that the limelight now focused on guided missile and space projects is diverting concern from the requirements for aircraft and conventional forces "in being."

Economy Bloc

The powerful bloc of economizers will be a brake on moves by Mahon, Jackson, Symington and others who probably will propose increases in the President's defense budget. Despite Russia's satellites, Sen. Harry Flood Byrd (D.-Va.), chairman of the Senate Finance Committee; Rep. John Taber (R.-N.Y.) ranking minority member of House Appropriations Committee, and others are approaching the budget to find areas of "fat" to trim, in the way of "unnecessary" military projects, as well as non-military programs.

Byrd called the President's overall $74 billion budget "reckless" and said: "It is likely to lead to substantial deficit spending with all of its evil consequences. Under conditions facing us now it is more imperative than ever before to maintain the soundest possible conditions in federal fiscal policy."

"In view of the continuing necessity to increase essential expenditures for missiles, satellites etc. to assure a balanced budget and a sound economy for the coming year and the future it is absolutely necessary to cut non-essential expenditures in all areas—military, civilian, and foreign aid."

Johnson Summarizes

In addition the military services will be in indirect competition for funds with agricultural welfare and other programs which have strong congressional support.

Sen. Lyndon Johnson (D.-Tex.), Senate Majority Leader, summarized:

"The question to ask about any budget is whether it is the right size to do the job that must be done. (The budget) will be analyzed thoroughly. And Congress will attempt to determine whether it is adequate to strengthen the nation's security and sustain the nation's welfare. There will be conflicting judgments as to its adequacy, and these judgments will have to be weighed carefully after all the facts are gathered."

However, if proposals for increased defense funds are supported by military testimony, it is doubtful that many members of Congress will vote against them.

Supplemental Hearings

Congressional interest in pushing top priority defense programs is shown by the speed with which the House Armed Services Committee and House Appropriations Committee acted on an accelleration of the Fiscal 1958 program.

• **Opening hearings promptly,** House Appropriations expects to complete hearings and report out for action on the House floor this week the President's request for an additional $1.2 billion. This provides for Strategic Air Command alert and dispersal facilities, $219 million; ballistic missile detection facilities, $329 million; ballistic missile acceleration facilities, $683 million; Semi-Automatic Ground Environment System, $29 million.

• **House Armed Services Committee** acted on legislation authorizing the construction proposals in this $1.2 billion program even before a formal request was received from the Administration. These total $549 million and include SAC alert construction, $24.6 million; SAC dispersal construction, $194 million; ballistic missile detection construction, $189 million; ballistic missile acceleration construction, $112.4 million; SAGE construction $29 million.

Rep. James Patterson (R.-Conn.), a member of the House Armed Services Committee, declared that the $194 million for SAC dispersal construction "is not enough. It does not provide for urgently needed new bases, but only covers construction of pavements, aircraft shelters and dormitories on bases already authorized."

Two proposals in the President's budget appear headed for flat rejection by the Congress: authority to transfer up to $2 billion from one service to another and a $500 million "blank check" to use on unanticipated military projects.

The congressional view is that this authority would give the President, in effect, power to determine the roles of the three services.

Roadblocks Still Curb Missile Production

By Ford Eastman

Washington—Acceleration of ballistic missile production is still being delayed despite warnings that the U S must move full speed ahead to meet the Soviet challenge, the Senate Prepared ness Subcommittee was told last week by both industry and Air Force leaders

U S lag in the missile race was blamed on government "red tape," in decision and trimming of budget requests that results in inadequate funds and the lack of a sense of urgency

Specific recommendations calling for accelerated production, increased spending and reorganization of the armed forces also were presented to the subcommittee Witnesses appearing before the subcommittee agreed it is still not too late to meet and overcome the Russian challenge if the U S moves without delay

George M Bunker, president of the Martin Co , prime contractor for USAF's Titan intercontinental ballistic missiles, told the subcommittee that he has been trying for six months to get a government decision on an accelerated production schedule for the missile

Bunker: 'Full Speed'

Bunker said development of the missile had been rapid, and that it should be ordered into production immediately in order to take advantage of the progress already made

"It is imperative that this country move full speed ahead into the full development of a program to take us into outer space," Bunker said

The Martin president blamed the indecision over the Titan program on the numerous civilian authorities and committees that have a voice in the project

"In arriving at major decisions, too many people have the power of negative endorsement," he said "They have the authority to say, No, but not the authority to say, Yes" He added that "there is nowhere to go to get an absolute clearcut decision that will stand up "

Maj Gen Bernard A Schriever, head of USAF's Ballistic Missile Division told the subcommittee that production of the Thor intermediate and Atlas intercontinental ballistic missiles "can and should be increased" beyond what the Eisenhower Administration has authorized (see page 28)

Gen Schriever said he has submitted both verbal and written recommendations for an accelerated production schedule and for more missile units, but that the only response has been "directives looking toward a program that is lower than physical capabilities would permit" Schriever added however, that development of the Thor and Atlas missiles—as opposed to production—is proceeding adequately, but he thought that the development program for the Titan could be accelerated

Gen Thomas D White, USAF chief of staff, testified that the President's new budget ignored his request for an acceleration of the Titan project He also said he was refused an additional $40 million he had requested for the Atlas intercontinental missile program, although the program was speeded up

In addition, Gen White warned the subcommittee that the Strategic Air Command has been denied $700 million in the new budget As a result he said, SAC "will be going downhill relative to the Soviet threat" two years from now unless funds are provided to continue and increase production of Boeing's B-52H intercontinental bombers

Sen Lyndon Johnson (D-Tex) subcommittee chairman, reported that Air Force missile requests for Fiscal 1959 budget were cut by 42% He added

"This is three months after Sputnik," he said "A cat gets his eyes open in nine days"

Another witness, Rear Adm Hyman G Rickover, the Navy's atomic submarine chief, accused the Budget Bureau of withholding funds appropriated by Congress for development of nuclear powered submarines He charged that, although Congress provided funds for the fiscal year that began last July 1 the Budget Bureau thus far has not provided the money for "one or two of my items"

Adm Rickover said the Navy is now designing nuclear powerplants for submarines that should last for almost an entire war without refueling He said it also is developing facilities to produce oxygen from seawater that will permit submarines to remain submerged almost indefinitely He added that he was absolutely certain that eventually it will be possible to launch an IRBM from a submarine

Defense Secretary Neil McElroy told the House Armed Services Committee that the 1959 budget contains funds to build atomic submarines designed to carry and fire the Polaris fleet ballistic missile and for missile components The Polaris test vehicles will be fired during the next fiscal year which begins July 1 Navy hopes to have the 1,500-mi missile operational by 1960

David Sarnoff, chairman of the board of Radio Corp of America, spelled out his ideas to the subcommittee on how to meet the Soviet challenge in a 10 point program

Sarnoff is a member of the Rockefeller Committee which earlier released a report on international security (AW Jan 13, p 34). His recommendations include

- **Rockefeller Report**—Implementation of its recommendations including changes in the Defense Organization which call for a principal military adviser to the President and Defense Secretary
- **Military Research and Development**—Suggestions that research should be placed in a separate agency outside the Defense Department is neither necessary nor desirable
- **Anti-Missile Missiles**—"I believe it is feasible to build an anti-missile missile system that would provide worthwhile results and add to our national security I recommend an accelerated effort to produce such a system and bring it to an operational stage at the earliest possible time"

Robert E Gross, board chairman and chief executive officer of Lockheed Aircraft Corp told the subcommittee there is an alarming need for a firm, clear cut policy on national defense with a definite plan for implementing it

Such a policy, he said must stem from the President and be agreed to by Congress Although the growing Soviet strength has been known for some years, Gross said the U S has not geared its defense program to cope with realities

"It is ironical that in the same newspapers recording the Russian Sputniks, were reports of cutbacks stretchouts and cancellation of contracts for weapons essential to our armed forces because of funding problems and payment limitations It is high time we, as a nation, face the facts of life The people must be told the gravity of our situation and what is required to strengthen our defenses and regain our respect in the community of nations"

Gross called for a strong positive leadership, a realistic reappraisal of defense requirements a renunciation of political considerations a workable plan and adequate funds to get the job done The responsibility for these policy decisions rests primarily with the President, the Defense Department and the civilian departments of the military services he said

'Ponderous Procedures'

One of the most important single obstacles to be overcome Gross pointed out is "the ponderous and cumbersome procurement procedures inherent in the present system that make it virtually impossible to get the quick decisions that are fundamental to any effective development program"

Gross added that if the armed services are given a plan and the authority to make decisions within their fields of responsibility and freed of red tape and interference, the U S can soon regain its position of leadership and be prepared to defend the nation against any aggressor

Gavin Says Army Needs Big Helicopter

U S Army has an immediate requirement for a helicopter approximately equivalent to the Soviet's Mi 6 heavy cargo turbojet helicopter (AW Nov 18, p 34) but has no prospects of getting it under present budgetary limitations according to Lt Gen James M Gavin, Army's retiring Chief of Research and Development

Gen Gavin, speaking last week before the Wings Club in New York said that at the present the Army's entire concept of combat was based upon achieving increased mobility

Army last week announced that Gen Gavin will be succeeded as deputy chief of staff for research and development by Lt Gen Arthur G Trudeau, ao engineer and at present a corps commander in Korea

Information Change Announced by AIA

Washington—Major share of Aircraft Industries Assn s public relations activities now handled exclusively by Hill and Knowlton Inc is being transferred to a staff on the payroll of AIA and under its jurisdiction Hill and Knowlton will continue to act as public relations counsel for the association

Effective Feb 1 AIA will move Hill and Knowlton's resident staff into the association's structure The group which will sever its connections with the public relations firm will be headed by Burton E English, now assistant director of public relations on Hill and Knowlton's AIA staff

Avery McBee vice president of Hill and Knowlton and until now director of public relations for AIA, will continue to direct the company s Washington operations He relinquishes his AIA title but will serve as principal liaison between Hill and Knowlton and AIA

AIA's public relations operation—whether it should be handled by an outside firm or within the association—has been a controversial issue among AIA members for several years

As sole representative for the association Hill and Knowlton has received a set public relations fee plus funds to cover salaries and expenses of the AIA account

Compromise Reached on G.91

Paris—Compromise agreement appears to have been worked out by NATO advisory lightweight fighter committee under which Italian Fiat G 91 would be recommended to NATO as its "first generation" strike fighter while its second generation lightweight fighter would be French with a more powerful engine

This recommendation reportedly has been forwarded to SHAPE headquarters by the lightweight strike fighter advisory committee Group met Jan 8 in Paris for the purpose of correlating flight test data on five entries Presumably the next step is for SHAPE to rule on the matter and in turn pass its recommendation on to the NATO council for a final decision

There was some confusion in Paris last week as to what exactly had been recommended by the ad hoc lightweight fighter committee This was because results of the Jan 8 meeting were being considered as classified information Committee members include representatives of nations interested in the lightweight fighter project as well as a representative from SHAPE headquarters Group is sponsored by Dr Theodore von Karman, chairman of the Advisory Group for Aeronautical Research and Development (AGARD)

Von Karman was unavailable for comment in Paris last week and both NATO and SHAPE officials working on the committee declined to comment.

Committee's recommendation according to French sources, is that NATO back the Fiat G-91 powered by the Bristol Orpheus 3 turbojet as an initial solution for the first generation of NATO lightweight fighters These aircraft French sources say, would be used most likely on NATO's southern flank, presumably in Italy, Greece and Turkey

But just how large a production order would be placed—or who would finance it—appear to remain open questions to be decided on a higher level

One figure cited in French circles was a Fiat order for 120 aircraft while another source mentioned a top figure of 200 aircraft.

Other side of the compromise reportedly is a committee recommendation that when the Bristol Orpheus 12 turbojet is ready then this engine will be used in the NATO second generation lightweight fighter which would be one of the French entries in the competition, presumably the Dassault Etendard 6 or Breguet Taon, Here again, production, quantity and financing were passed on to higher levels

This reported compromise solution is not exactly what the competition aimed at when it first began in 1954 Idea then was that an advisory committee would evaluate various entries and settle on the best type for the NATO strike fighter role United States funds were to be used as they have been on prototype development work, but production of the final winner was to be jointly financed by various NATO nations, several of whom also would share in its production

It is no secret in NATO circles that even if the advisory committee reported recommendations on the Fiat finally was approved, the only way the Italian fighter will be produced will be if the United States finances its production Other NATO nations have shown little interest either in putting money into the Fiat G 91 orders or in participating in its production In fact there is a good deal of doubt here whether the lightweight fighter ever will become a serious production program

Five aircraft were involved in the competition, of which four were French Designers were expected to produce an aircraft capable of Mach 0 95 on the deck able to take off pierced steel planking grass or highway able to clear 50 ft in less than 3 000 ft and able to roll at 100 deg per second Empty weight was originally restricted to 5 000 lb

Of five entries three planes were built to these requirements using the Bristol Orpheus 3 turbojet which also was helped in development by United States funds These three were the Dassault Etendard 6 Breguet Taon and Fiat G 91 Two other entries not designed to the original specifications came into competition at a later stage These two were Dassault's Etendard 4 and Sud Aviation's Baroudeur both powered by Socema Atar turbojets and both considerably above the weight limit All five aircraft were flight tested last September at Bretigny in France

NATO test pilot's summary of flight test reports was said to favor Fiat French pilot reportedly signed summary Jan 8 after this compromise That committee currently accept fact that the Fiat is the only aircraft meeting all mission requirements and recommended ordering it, but also recognized need for second phase development and a later date competition for a second order

While the French are not expected to protest the committee s reported Jan 8 recommendation partially because it promises a possible future order for French aircraft many French industry and government officials appear to be bitter French claim that committee s belief that Mach -8 deck speed would suffice in place of original 95 favored Fiat.

Rocket Mergers May Be Start of Trend

By Michael Yaffee

New York—Quiet negotiations over the past few months jelled last week in three alliances between motor manufacturers and propellant makers

- **North American Aviation Inc** and Phillips Petroleum Co. formed Astrodyne, Inc., a jointly owned firm which will specialize in the solid propellant field
- **Aerojet-General Corp.** allied itself with Stauffer Chemical Co. in a joint partnership agreement, formally known as Stauffer Aerojet Co., under which the two firms will work on the development of boron-based propellants
- **Thiokol Chemical Corp** entered a working relationship with Callery Chemical Corp on the development of rocket engines which will use the new solid form of Callery's HiCal boron-based high energy fuels

Signs of Trend

More significant perhaps than any individual marriage in the missile motor field there are numerous signs that the recent alliances are only the start of a major trend. Finding the right partner and working out agreeable partnership conditions, of course, is generally a long and difficult task but it is fast becoming a necessary one.

Among those still unallied and primed for some such tie up are Hughes Aircraft Co., Grand Central Rocket Co., Aeronutronic Systems Inc., Goodyear Aviation Products Division, Hercules Powder Co., Atlantic Research Corp., U. S. Borax, and AFN (a joint high energy fuel undertaking of American Potash & Chemical Corp., Food Machinery & Chemical Corp., and National Distillers & Chemical Corp.)

Among the more obvious reasons for the alliances is the aforementioned big business aspect. Rocket engines—including hardware, propellants and associated controls—have grown into an industry with annual dollar volume approaching an estimated $750 million. Until recently, Aerojet and Rocketdyne dominated the field almost completely. Now, to maintain their standing against rapidly growing companies as Thiokol, the two leaders have found it expedient to consolidate their positions. At the same time, the smaller firms, as Thiokol find it even more essential to form their own alliances to continue their growth.

For the chemical members of the marriages, of course, it is predominantly a matter of market development. The closer a company is to the end market the easier it is to develop and control the end use pattern.

Stauffer, basic in borax and boron chemicals, was limited to supplying the intermediate boron trichloride to Olin Mathieson. Not only was Stauffer unable to control the end use pattern but, in addition, it soon found itself in a competitive position as an intermediate supplier. To little avail, the company tried to crack the end product field by going directly to the government. This resulted in a few non-profit research contracts which gave the company access to hitherto unavailable data but little else.

Government Push

Another stimulus to rocket engine alliances, also an outgrowth of the industry's rapid rise and current bigness, comes from the government itself. In the beginning, the government was generous in providing the engine makers with money to produce their own propellants. As the business grew, the demand for propellant money became a noticeable drain on the military budget. Then, when more chemical companies entered the field, they brought with them facilities and know how that were adequate for everything from propellant research to production.

Continued support of the engine makers for propellant work, the government decided, was leading to costly and unnecessary duplication. Last month (AW Dec. 23, p. 26), the Air Force suggested the possibility of affiliations to a number of firms.

One of the most significant factors behind this splurge of engine-propellant alliances is the change now taking place in the field of propulsion technology itself, namely, the fast growing acceptance of solid fuels for ever bigger jobs (AW Oct. 7, p. 50, Dec. 23, p. 37).

The arguments against solid fuel rockets—lack of efficiency, thrust and controllability—are proving untenable as a result of recent advances in the state-of-the-art. Moreover, say the solid adherents, solid fuel rockets offer greater reliability and economy, are easier to handle and require a shorter countdown.

The rapid and successful development of the Polaris is proving another powerful weapon in the arsenal of pro-solid arguments. Even more important is the government's newly evolved interest in solid versions of the Redstone and Thor. It is believed the solid fuel models of these missiles can be made considerably smaller than the current models and still achieve twice the range capability.

There has also been some high level talk about turning the Titan into a solid propellant missile provided a large enough engine can be developed in time.

Solid Contracts

Almost certain to result in sizable production orders, the contracts for the solid fuel Redstone and Thor were at the latest report still up for award. Whether or not the North American-Phillips alliance gets the nod on these specific contracts, a company such as North American cannot afford to overlook this swing to solids.

As far as Thiokol is concerned, the tie-in with Callery is not expected to have any bearing on the immediate picture. Rather according to Thiokol President J. W. Crosby, the alliance is expected to give the company a significant jump on its competitors in the development of a high energy solid fuel rocket engine. It will also help in keeping Thiokol competitive with its liquid propellant counterparts, provided they develop something such as a practical fluorine motor within the next two years or so. For Aerojet, a major figure in both fields, the alliance with Stauffer will serve as general coverage insurance against encroachments from almost any direction.

Olin Mathieson Chemical Corp. and

Pressurized Commander To Cost $183,750

Oklahoma City—Aero Design & Engineering Corp. will place the first light twin business transport with a pressurized cabin on the market this spring at a price of $183,750. Basically a revised version of the company's Aero Commander 680, the new Alti-Cruiser has a cabin differential of 5,000-7,000 ft., giving equivalent of 9,000 ft. altitude while the airplane is cruising at 15,000 ft. Pressurization system takes about 10 hp. from each of the Alti-Cruiser's 340-hp. supercharged Lycoming engines; cabin supercharger is a single-stage centrifugal compressor built by Stratos Division of Fairchild Engine & Airplane Corp.

Two models, a four-seater with lavatory and a six-seater without, will be available. Performance is similar to the 680 Super—cruise speed of 230 mph. at 65% power at 15,000 ft. Aero design hopes to sell 50 Alti-Cruisers this year.

Prototype Alti-Cruiser suffered major damage on takeoff just prior to unveiling the new plane to the company's distributors and dealers here, but the pilots escaped with minor injuries. Investigation showed that faulty fuel gages indicated sufficient fuel in the main tank, when actually it was empty.

Douglas Mates DC-8 Wing, Fuselage

Progress of Douglas DC-8 jet transport assembly is indicated by this photo of the beginning of mating of wing and fuselage. Aircraft now is virtually complete but this is first photo showing even this much of the first airplane. Hoists were flown to Douglas by Harnischfeger Corp. from Milwaukee plant three weeks early for ceremony Douglas planned for mating.

Reaction Motors Inc. actually set the pattern for the alliance of chemical company and engine manufacturer back in 1953. At that time, the companies decided that their common interest in liquid propellant rocket engines was strong enough to justify some sort of combined effort. And so in December 1953, Mathieson bought out RMI. This eventually resulted in the OMAR combination.

Last summer, the companies decided to extend this joint effort into the solid propellant field. Today, Olin Mathieson and RMI have $10 million worth of facilities active on solid propellant work and at least two government contracts in their collective pocket for development of solid fuel engines.

Pattern they worked out for pooling their efforts in solid fuel development:

- **Initial research** is carried out in parallel programs by RMI at Rockaway, N.Y., and Olin Mathieson at Niagara Falls, N.Y.
- **Work** is then turned over to Olin Mathieson's facility at East Alton, Ill., for development stretch as a propellant. At the same time, RMI runs a parallel development program at Rockaway.
- **Once the propellant** is developed it is farmed out to Olin Mathieson's plant in Ordill, Ill., for production. Meanwhile, RMI starts working on motor design and hardware.
- **Quantity production** of the finished engine, i.e., with the propellant already inside, will take place at Ordill. RMI is and will continue to be prime contractor on all joint bids the companies submit to the government.

This is essentially the same pattern Aerojet and Stauffer will follow in their alliance. As a corporate entity, Stauffer Aerojet Co. is only a paper project at present. Until some joint facility is set up, each firm will continue to use its own laboratories and plants.

Stauffer, according to one company spokesman, does not intend to limit its joint participation with Aerojet to the development of borane based fuels. The feeling at Stauffer is that the company can contribute a great deal of chemical processing know-how beyond that concerned with boron technology.

This know-how, says Stauffer, extends to non-borane propellants (both solid and liquid), high temperature polymers (for use in hydraulic fluids and gaskets among other applications) and refractory materials. One of the projects now underway at Stauffer is the development of a "re-entry material." Aerojet, says its chemical partner, can tie all these activities up in one neat package.

Thiokol's relationship with Callery, on the other hand, is less formal and based almost solely on Callery's ability to supply a boron based solid fuel. In the beginning, Callery will also work with Thiokol on the development of a solid oxidizer for the new fuel.

Thiokol's object is to develop higher thrust, higher performance solid propellant rocket motors that will take advantage of the significantly higher specific impulse potential of the borane fuels. Development work on this project has already started at Thiokol's Elkton and Redstone Divisions.

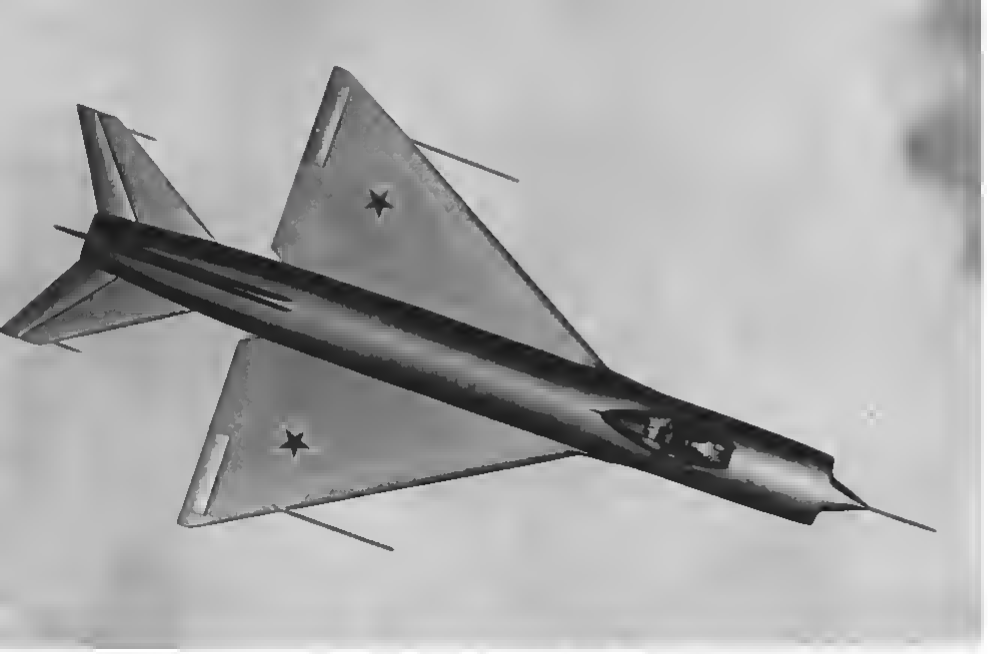
Once the development work is finished, Thiokol will go into production with the engines either at its own plant in Elkton, Md., or the Thiokol-operated government plant at Marshall, Tex. If the development work results in any very large engines, the company will assign production to its newest facility in Brigham City, Utah, which was specifically designed for testing and production of large rocket engines. Callery will supply fuel and, possibly, oxidizer to Thiokol either in solid or slurry form.

So far, the results of the development work on a solid borane engine have been encouraging, says Thiokol President Crosby. But it will be at least two years, he believes, before Thiokol will start loading the new propellant into an engine.

Astrodyne, Inc., the offspring of North American and Phillips, will establish its headquarters and operations at Air Force Plant 66, near McGregor in Central Texas, where Phillips has conducted research, development and production of solid rocket units for the Air Force since 1952.

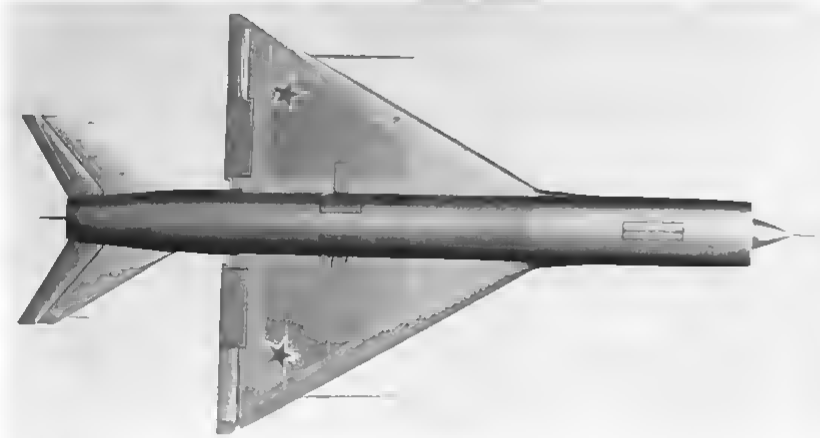
As yet, Astrodyne has no contracts and neither of the parent firms is talking in terms of long range objectives. As one North American official pointed out, they still have to settle the usual corporate problems of who is to run the show and how it is to be run. The only plans discussed so far concern the transfer of employes from the parent firm to Astrodyne.

With or without any specific plans, the alliance between Phillips and North American shapes up as perhaps the most significant one for both industry and government. Phillips has gathered a great deal of experience in the development and production of very large solid engines and North American has the overall systems knowledge gained from its work with large liquid engines to make the big solid motors both useful and attractive.

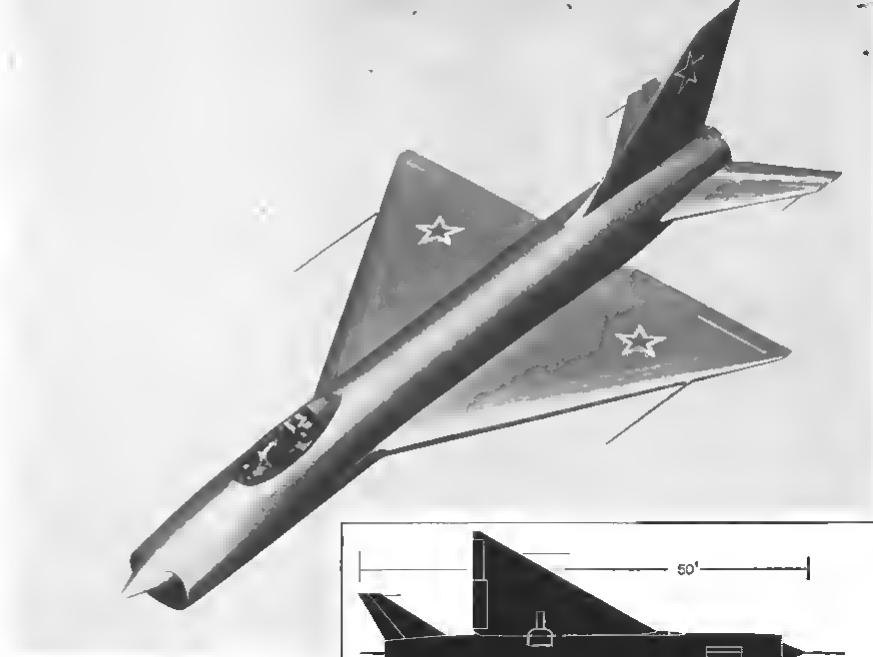


Fishpot planform view shows location of flaps and elevons and nose radar installation of all weather fighter

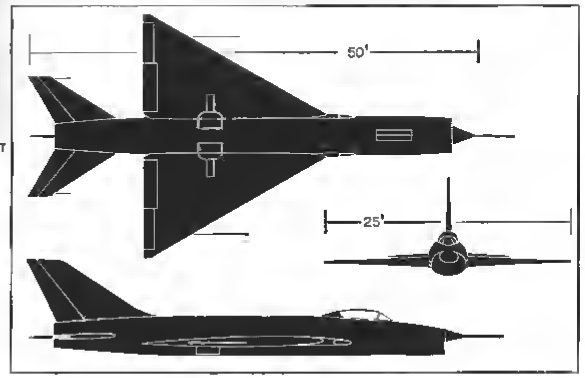
Fishpot in Production; Backfin Flies as Prototype



Bells view shows where main landing gear retracts inward, nose wheel rearward into fuselage. Large chin type inlet for 22,000 lb. thrust engine is visible below nose radar.

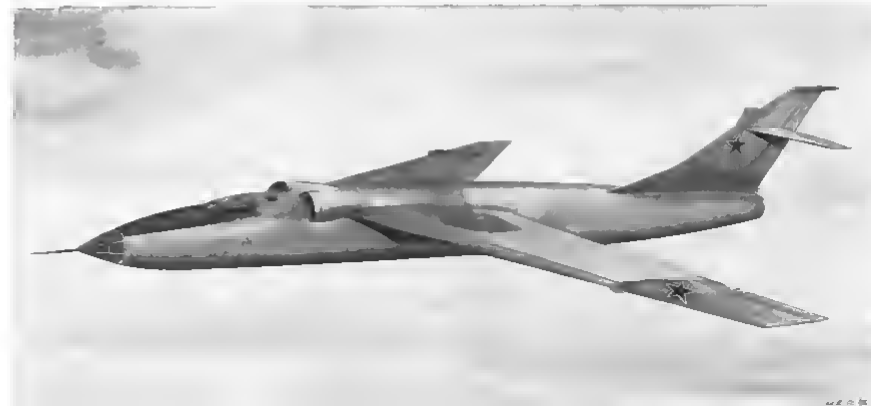


FISHPOT



Red air force all weather fighter designed by Pavel Sukhoi is now in production. Code named Fishpot by NATO, the Sukhoi fighter uses a 22,000 lb. thrust turbojet engine that gives it a top speed better than twice the speed of sound. Length is 50 ft., span 25 ft. with a 52 in. diameter tail pipe. Fishpot has been seen flying in Moscow area in squadron size formations. Prototypes flew publicly in 1956 Tushino air show. Backfin is NATO code name for new supersonic Soviet light bomber now flying in prototype form.

BACKFIN



Navigation Proposals Cut in CAA Budget

Largest CAA budget falls $30 million below needs; President proposes increasing gas, jet fuel taxes.

By L. L. Doty

Washington—Largest budget in Civil Aeronautics Administration history was proposed by President Eisenhower last week for Fiscal 1959, but the total still falls $30 million short of funds required for the establishment of air navigation facilities under the agency's Federal Airways Plan.

In his budget message to Congress, the President also urged the adoption of legislation providing a progressive increase in aviation gasoline and jet fuel taxes during the next four years as a means of offsetting airways costs. Under the proposal, taxes on fuels to private users of the airways would reach 6½ cents a gallon by 1962 and would cost the scheduled airlines approximately $167 million compared to an estimated $25 million last year. At present, there is no tax on jet fuel.

The President made a similar proposal in his budget message last year, but this marks the first time he has spelled out a specific system for revising the fuel tax structure. As another means of bringing about economies in airways operations, the administration emphasized that joint use of certain facilities, such as long-range radar" would be expanded by the Commerce and Defense Departments.

Civil Aeronautics Administration has estimated that $202.4 million will be required in Fiscal 1959 for the establishment of essential air navigation facilities and $232 million for maintenance and operation costs.

The budget calls for only $175 million and $230 million respectively in each category. Revenues from fuel taxes, if adopted, will not increase these amounts but will be applied as offsets to the requested appropriations.

Overall CAA budget requests by the President amount to $471 million. This compares with an estimated $385.6 million that will be required through Fiscal 1958 and to $278 million actually enacted in Fiscal 1957.

CAB Proposal

The budget proposals also include an increase for the Civil Aeronautics Board from $42.7 million in Fiscal 1958 to $46.8 million next year. A substantial part of the increase is reflected in an increase of payments to air carriers, and the President urged the adoption of means of reducing and "ultimately eliminating all subsidies for airlines."

For the newly formed Airways Modernization Board the President asked for obligational authority of $35 million for research and development of air traffic control and navigation facilities. By the end of Fiscal 1958, cost of AMB is expected to reach $15.1 million.

In his tax proposal, the President called for an immediate levy of 3½ cents a gallon on jet fuels and an increase on aviation gasoline from the present 2 cents a gallon to 3½ cents. Thereafter, both taxes would be boosted ½ cent a year for the next four years until a maximum tax of 6½ cents is reached in 1962.

In his message, the President explained that ' the receipts from taxes on aviation gasoline, which now go into the highway fund, should be kept in the general revenues to help finance the operations of the airways."

ATA Protests Tax

The Air Transport Assn. was quick to point out that the approximate $25 million paid out in fuel taxes in calendar year 1957 was approximately the same as the estimated total net profits earned by the scheduled airline industry last year (AW Dec. 30, p. 39).

The group estimates that, under the President's proposal, taxes this year will reach $49 million as compared with an anticipated $28 million which would have been paid out under the present tax structure. The new rates will bring the tax cost to airlines to an estimated $70 million in 1959. By 1960, taxes will have climbed to $101 million and to $141 million in 1961.

Capital Airlines, the only U.S. carrier using kerosene fuel which is not now taxable, will pay out $2.4 million in taxes if the legislation is passed by Congress.

Major increases in the Civil Aeronautics Administration budget were attributed to the heavy workload generated by increased traffic, operation of newly commissioned radar and training new controllers and maintenance personnel. Number of employes will rise in Fiscal 1959 to 28,043 as compared with a 22,676 level in Fiscal 1958.

The budget calls for $38.3 million for the CAA's Vortac program in Fiscal 1959. Under CAA's Federal Airways Plan, an estimated $74.2 million would be required in Fiscal 1959 to maintain its schedule of establishing a total of 513 Vortacs by 1962.

Long range radar is likely to suffer a similar setback under the budget proposals. CAA wants to implement a total of 73 long range radars by 1962 and has estimated the project can be completed by the end of Fiscal 1959 if $53.6 million could be appropriated that year for this purpose. However the Administration's budget asks for only $25.6 million.

The budget calls for $16.8 million for terminal area radar as compared with a CAA estimated requirement of $16.1 million in Fiscal 1959. For operation and regulation of the federal airways, an appropriation of $204.8 million has been recommended. A total of $20.8 million has been asked for flight operations and airworthiness and $4.3 million for airports.

Appropriation recommended for the Civil Aeronautics Board in fiscal year 1959 is $40.7 million, an increase of $3.5 million over the 1958 appropriation. Number of CAB employes will rise from the present level of 695 to 745. Fiscal 1957 figure was 602.

Subsidy payments to domestic trunk line carriers will be dropped entirely in Fiscal 1959, but payments to local service carriers will rise from an estimated $31 million this year to $32 million in Fiscal 1959. In 1957, local service carriers received subsidies totaling $25.8 million. Northeast Airlines is the last trunk carrier still on subsidy.

Hawaiian territorial carriers will be off subsidy in Fiscal 1959, but seven Alaskan territorial airlines will be paid $5.7 million as compared with an estimated $6.1 million in 1958. Only one international airline, Braniff Airways, received subsidy last year. Subsidies will decline to $781,000 as compared with $1.2 million in 1958.

Three helicopter lines will receive $4.1 million in subsidies in Fiscal 1959, a slight decline from the estimated $4.5 million paid out this year. The Civil Aeronautics Board fixes rates for the carriage of mail. Subsidy elements are included in the rates where authorized, and the Post Office Department pays only the service portion of the rates. The CAB covers the subsidy portion.

AMB Estimate

The 1959 estimate for the Airways Modernization Board is to cover an accelerated research and development program for airways with the work being performed largely by contract with private firms. Number of permanent positions recommended by the budget is increased from a Fiscal 1958 figure of 106 to 371. AMB expects to fill at least 364 of these positions during fiscal year 1959.

Acquisition of land and buildings for an AMB test center at a cost of $4.5 million is recommended in the budget. Equipment including an electronic air traffic simulator will amount to $7.9 million in Fiscal 1959 as compared with $2.3 million in 1958. For contractual services, a total of $10.7 million has been requested for Fiscal 1959.

ACC Proposal

Services performed by other agencies will cost the AMB $8.9 million according to the budget recommendations. Other major items in the AMB budget are $12.5 million for "systems experimentation" and $15.2 million for "executive direction and administration."

An appropriation of $250,740 was recommended for the Air Coordinating Committee. A breakdown of program activities shows $113,000 allocated to the Defense Department, $28,000 to the CAB, $23,000 to Commerce, $24,000 to the Federal Communications Commission and $18,000 each to the Post Office, State and Treasury Departments. The Civil Aeronautics Administration is represented in the group through the Commerce Department.

For air transport mobilization planning to insure a strong air transport system in time of war, the administration asked for $79,900, comparable to last year's $79,700.

Civil Aviation—New Funds

(In millions)

	FY 1957 (Act.)	FY 1958 (Est.)	FY 1959 (Est.)
Civil Aeronautics Administration Total	$278.4	$384.8	$471.7
CURRENT AUTHORIZATIONS			
Operation and Regulation	136.8	181.7	230
Establishment of Air Navigation Facilities	75	124.8	175
Airports (Washington, D.C., and Alaska)	2.1	2.5	3.7
Air Navigation Development	1.5	2	—
Additional Washington, D.C. Airport	—	12.5	—
PERMANENT AUTHORIZATIONS			
Airport Grants-In-Aid	63	83	63
Civil Aeronautics Board Total	23.8	42.7	42.8
CURRENT AUTHORIZATIONS			
Salaries and Expenses	4.8	5.5	8.1
Payments to Air Carriers	18.2	37.2	40.7

BOAC May Fly Only VC. 10s After 1965

London—First details of the Vickers VC 10 long range jet airliner were released when officials of Vickers Armstrong Ltd. and British Overseas Airways Corp. signed a contract for 35 aircraft valued at $163 million. At 299,000 lb. gross weight it is the biggest British aircraft since the Brabazon and the contract the largest ever awarded the industry for a civil machine.

Modifications to the design and original bypass powerplants made since the order was first announced now enable BOAC, according to a company statement, to operate all its routes in both the eastern and western hemispheres with this one "all purpose" aircraft.

This means Britain now is in the market with a nonstop transatlantic jet airliner.

1961 Rollout Date

The first aircraft is expected to roll out late in 1961 and a fleet of 10 machines is scheduled for delivery to BOAC in 1963. But the size of the order together with the fact that the company has taken an option on an additional 20 aircraft indicates the possibility that BOAC may sell its Comet, Britannia and Boeing 707 aircraft after 1965 and operate a fleet entirely made up of VC 10s.

Because of the larger engines promised from Rolls-Royce, the aircraft is considerably bigger than the original specification. The wing span is 140 ft., wing area 2,800 sq. ft., overall length 158 ft. and its double bubble fuselage has a depth of 148 in. and a floor width of 132 in. The undercarriage is wing mounted and retracted and has a gravity fall as with the Vanguard.

Unusual configuration of the aircraft derives from:

- **Mounting** of four bypass engines in transverse pairs astride the rear fuselage.
- **Location of swept** cranked wing with leading edge more than half way aft from the nose. Engine location allows full length flaps and leading edge slats.
- **Swept tail** mounted on top of 41-ft.-high fin.

The engines are a derivative of the Rolls Royce Conway bypass engine which now has a military rating of 17,500 lb. thrust, but design and development details are cloaked behind a military application. An outstanding low fuel consumption was unofficially quoted for this engine when it first ran.

Attacks Field Limitations

Claiming the aircraft to be ' a world beater,' Sir George Edwards, managing director of Vickers said the VC 10 was the "first big jet aircraft to take advantage of the attack which modern design knowledge can launch on one of the big handicaps of the pure jet age—its airfield limitations."

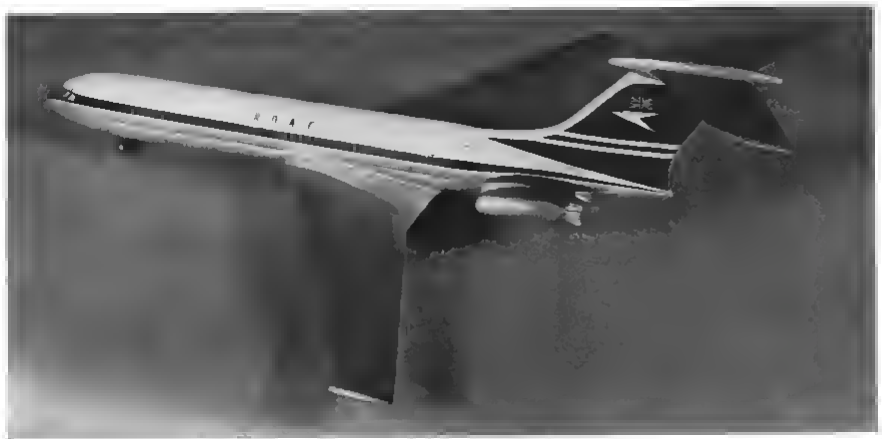
Because it will enter service after its known competitors it was necessary to leapfrog known competition and for this reason the company has placed most emphasis on the achievement of better airfield performance but without introducing insufficiently developed high lift devices. The most obvious step along this route was to get the engines out of and away from the wing. "The engines are where they are," Sir George emphasized, "to get a clean wing and not to make it quieter." Company policy prevented release of performance or airfield details at this point but a well informed company source told AVIATION WEEK that the Royal Aircraft Establishment gives the VC 10 a clear 25% better airfield performance on a length-altitude basis than its nearest competitor—the Boeing 707. This puts the takeoff distance for the VC 10 at between 4,000 and 6,000 ft. according to stage length.

Cruise Performance

The wing is also claimed to have a particularly good cruising performance and has a 0.02 Mach number advantage over the Boeing 707.

The high but unspecified lift-drag ratio is achieved principally by the use of 100% span flaps and leading edge slats. This arrangement is only possible with fuselage-mounted engines which leave the wing entirely free from breaks from tip to root. As yet use of blown flaps, developed for its military aircraft is not envisaged.

High location of the tail plane was not due to the proximity of the exhaust gases—an intermediate location would have sufficed and there would



VICKERS VC. 10 long range jet airliner will have 140 ft. wing span, 2,800 sq. ft. wing area, 158 ft. overall length. Double bubble fuselage will be 148 in. deep, with 132 in. floor width. Aircraft will have gross weight of 299,000 lb. Engines, mounted in transverse pairs astride rear of fuselage, will be derivatives of the Rolls-Royce Conway bypass engine which has a military rating of 17,500 lb. thrust. Engine location allows full flaps and leading edge slats, permits clean wing for gain in airfield performance.

have been a weight saving. It was found that with the crank wing configuration as used on the Victor bomber this wing-high tailplane relationship induces remarkably good handling characteristics, particularly at lower speeds, and makes the structural concession worthwhile.

Apart from the aerodynamic advantages of rear engine mounting, the new engine configuration will greatly reduce noise levels in the cabin and reduce vibrations due to buffeting from pod and wing-mounted engine exhaust.

The latest design details of the VC 10 were only decided two months ago following a reassessment by the engine company of the Conway development program. Rolls Royce was then able to offer a later and more powerful version of the engine with performance characteristics far exceeding those originally offered but which it did not think it could offer on time for a 1961 requirement.

American Earnings Drop

Drop in net earnings from $19,572,713 in 1956 to $10,885,877 last year is reported by American Airlines. The carrier's 1957 net included $1,791,659 from disposal of property, compared with $1,548,625 from this source in 1956.

American's revenues totaled $305,995,596 in 1957, up from $291,771,957 in 1956. Passenger-miles flown during 1957 totaled 5,142,593,342, up from 4,899,629,099 the previous year.

With the original engine, the smaller Vanguard fuselage was scheduled for the VC 10 and the aircraft was to have been confined to BOAC's African, Australian and Far Eastern routes.

The new version can now operate the North Atlantic and the South American routes without impairing its performance in the eastern hemisphere.

President Proposes Washington Air Site

Washington—Construction of a second airport to relieve the increasing congestion of Washington National Airport is scheduled to get under way in near future after ten years of bickering and delay.

Civil Aeronautics Administration has $12.5 million to start the project. The site selected by former USAF Lt.-Gen. Elwood Quesada, special assistant to the President for aviation planning, is in Chantilly, Va., an alternate to the much-disputed Burke, Va., site chosen originally by CAA.

The decade of opposition by the Maryland delegation to the construction of a new airport while the facilities of Baltimore's Friendship Airport were not being fully utilized apparently has come to an end.

Maryland's Sen. John Marshall Butler (R.) explained:

"Before the completion of the Chantilly project, Friendship will probably become the second air terminal for this area and Chantilly will become the third facility. The General (Quesada) predicts that even a fourth airport may be necessary five or six years hence. . . . I have consented to accept his recommendations respecting the location of another airport in the greater national capital area . . ."

Quesada reported that studies "indicated clearly that the combined demand of the Baltimore and Washington areas would soon exceed the combined capacity of Washington National Airport and a fully expanded Friendship Airport."

Anticipating the start of construction "within a few days," Sen. Mike Monroney (D.-Okla.), chairman of the Commerce Aviation Subcommittee, said:

The Chantilly site has many factors to strongly recommend it for development into one of the finest jet terminals of the nation. There are a few factors against it, principally the distance from Washington. Much can be done to overcome that, however, with through four-lane express highways."

Secretary of Commerce Sinclair Weeks promptly requested "immediate release" by the Bureau of the Budget of the $12.5 million appropriated by Congress last year which hinged on the designation of a site by Quesada. Weeks also asked Attorney General William Rogers "to take immediate steps for the acquisition of property" for the airport, and Civil Aeronautics Administrator James Pyle invited 90 engineering and architectural firms to submit by Feb. 3 statements of their qualifications to build the proposed airport.

Ground Handling May Decide Jet Battle

New York—Competitive advantage in the jet age will go to airlines with the best terminal facilities for handling passengers and aircraft, according to Marvin Whitlock, American Airlines' vice president-operations planning.

Speaking last week at the Society of Automotive Engineers meeting in Detroit, Whitlock noted that flight equipment is becoming increasingly uniform in design and performance. It will therefore be difficult for any airline to hold an edge over the competition in aircraft. Services remain as the controlling if not exclusive area of competitive advantage.

Inflight service has been improved greatly over the years and will reach a completely new standard in the coming generation of turboprop and turbojet planes.

The real opportunity to out distance the opposition lies on the ground, where the progress in improving the passenger's environment has been less satisfactory.

Time to Improve

Introduction of the turbine planes is an opportune time to improve the passenger's lot because new equipment and procedures will be needed to service the planes.

Along with the passenger's comfort, efficient ground handling and servicing will be vital because of the need for decreased ground times to get the most economically from the jets.

Whitlock lists minimum ramp requirements for conventional taxi-in and taxi-out with jet aircraft:

- **Sound-tight enclosure** with tightly sealed, closed doors for all passengers and visitors in the concourse area. Enclosures must be air conditioned and equipped with remote air inlets.
- **Blast fences.** Gate positions must be separated by fences at least 7½ ft. high, about 110 ft. long and abutting the concourse on one end.
- **Ear muffs** or better for all ramp personnel on the apron during engine operation.
- **Sound-tight enclosures** for all other ramp personnel during operation.
- **Ground servicing units** of adequate capacity—much greater in many instances with jets.
- **Improved ramp cleanliness** to avoid blowing dirt or water and to make taxi lines visible under snow and ice conditions.

Advantages of Provisions

These provisions, according to Whitlock will "contain and protect" at gates in use and provide environment at adjacent gates equivalent of today's.

Jets can taxi to and from gate positions using 200 ft. in center gate spacing.

Passengers can be loaded with conventional but self-powered stairs. If these minimum facilities are not available, compressor noise and exhaust blast must be excluded from ramp areas either by towing at least 500 ft. away from terminal, or by using passenger buses between terminal and remote loading site.

Towing or use of a wheel mover is undesirable, Whitlock says, because of delay, opportunity for damage to aircraft structure and expense of tow equipment needed for all-weather, long distance towing.

Buses offer promise for any terminal larger than those currently planned at Idlewild when time permits integration with the terminal layout.

Comfort Factor

These minimum requirements, however accomplish nothing toward improving passenger comfort or efficiency in handling passengers, Whitlock notes. American's studies, he says, indicated that second level concourses and passenger loading offered an inherent advantage in this area.

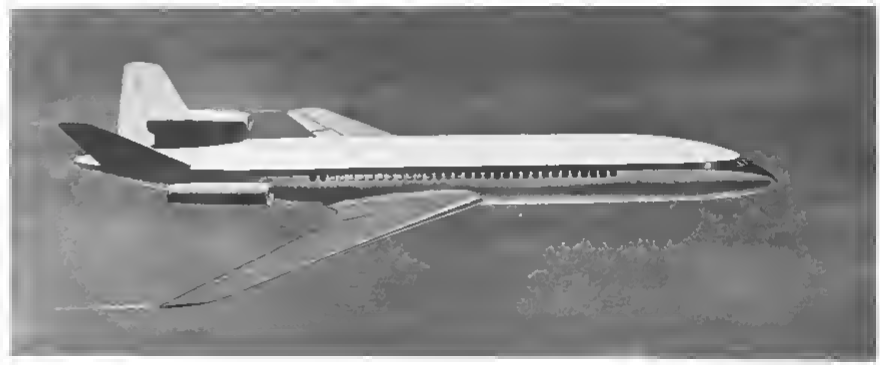
Everything that is done to the airplane except cabin servicing is done at ground level, Whitlock points out. On the other hand, the only level of interest to the passenger is the cabin floor level.

These and other reasons led to the American plan to taxi straight in, load at second level and push out to taxiing position with a tractor. The plan is exemplified in the airline's proposed terminal at Idlewild (AW Dec. 23, 1957, p. 79).

Servicing Needs

Whitlock also discusses servicing needs of the jets, including:

- **Fueling.** Most airlines will use kerosene which must be kept free of foreign matter such as water, mud or dirt of 5 microns or more diameter. New handling techniques will be required. No equipment currently used for gasoline



Avro 740 Designed for BEA

Avro 740, a 70-100 seat jetliner designed to meet British European Airways specifications, is depicted in this drawing. Project for this radical aircraft has been abandoned by Avro in favor of the Bristol 200 (AW Jan. 13, p. 39). Butterfly tail and three jet engines mounted aft on the fuselage distinguish the design.

can be economically adapted. Hydrant systems offer many advantages but require substantial capital investment.

• **Power.** The Boeing 707 uses more than 100 times as much electric energy as the DC-3, and most airports will require large increases in power supplied to the field if fixed installations are used. Lethal quantities of electricity will be involved and protective devices and additional care will be required for ground personnel.

• **Engine injection water.** This must be demineralized to protect turbine blades, and special equipment will be needed for storing it. Storage must be in stainless steel, plastic or glass lined tanks and pipes. Water can be dispensed by hydrant or truck, but none of today's equipment can be adapted.

• **Engine oil.** Here is a gain because the oil truck can be eliminated. Turbine engine oil consumption is in pints rather than gallons and can be hand carried or added at maintenance time.

• **Fire protection.** Standby equipment can be larger quantities of conventional types, but there will be a trend toward foam and power type agents.

Whitlock notes that jet size presents passenger handling problems in which a 150 passenger jet departure approximates four simultaneous Convair 240 departures.

American's answer in part is to construct a departure room at each gate position to permit pre-departure ticket collection.

ATA Completes Fare Testimony

Washington—Air Transport Assn. last week completed its presentation before the Civil Aeronautics Board's General Passenger Fare Investigation with testimony by consulting economist Jesse J. Friedman. Friedman, testifying in the seventh week of the hearings, told the Board that the concept of determining rate of return for public utilities cannot be applied to trunk airlines, because the basic economy of the airlines is more like the economy of non-regulated competitive industries.

ATA has previously contended in the investigation that airlines not only compete among themselves but with all other forms of transportation, with other markets seeking a larger share of consumer dollars and the decision not to travel at all. The airline industry does not hold the advantages of a monopoly public utility, the ATA has concluded.

Friedman presented a study in support of ATA's findings showing that net income of the airlines, before interest and after taxes was less than half of that for three utilities—electric, natural gas and telephone.

Collision Warning System Plans Fail to Arouse Airline Enthusiasm

Washington—Airlines appear to be taking a "show me" attitude toward two new proximity collision warning systems proposed by Minneapolis Honeywell and Federal Telecommunication Laboratories at recent Air Transport Assn. meeting in Los Angeles (AW Jan. 13, p. 38).

New technique disclosed by Bendix Radio, which might hold proximity collision warning possibilities, will require additional investigation to determine feasibility, company's Dr. J. S. Morrell told the Air Transport Assn.

Lack of marked enthusiasm for the Honeywell infrared system stems from general airline reluctance to use a cooperative system (which is effective only against suitably equipped aircraft) except as a last resort. Honeywell's system requires use of cooperating infrared beacons, consuming 500-1,000 w. power for collision warning mode of operation but can be operated as a simple proximity warning indicator against non-equipped aircraft, company says.

Honeywell considers its report a sort of interim status report and plans to continue its flight test program to obtain additional data, spokesman says.

Airlines Not Enthusiastic

System proposed by Federal Telecommunication Laboratories, using existing weather radar in combination with interferometry techniques, also reportedly failed to generate much airline enthusiasm. Airline representatives questioned whether echos from heavy rainfall would produce false alarms and indicated that proposed coverage in forward quadrant was too limited.

Federal Telecommunication Laboratories spokesman says company plans to revise its proposal to provide 120 deg. forward coverage then visit individual airlines to assess their interest before deciding whether to proceed.

Bendix Radio's Dr. Morrell emphasized that company was reporting on new technique which might have possible application to the proximity-collision warning problem but was not making a system proposal. Technique can provide information as to whether intruder airplane is at or near same altitude as own plane, plus information on distance to intruder and his closing rate. As presently conceived, technique does not provide information on intruder bearing, and requires both aircraft to carry at least a small radio transmitter and a small receiver.

Transmitter in one airplane ("A") periodically transmits a sequence of pulses, each pulse separated by a time interval proportional to plane's altitude.

When these pulses are received by another airplane ("B") in the vicinity, the pulse spacing is analyzed to determine whether both aircraft are at or near the same altitude as the first step in determining whether collision threat exists.

Pulses also bounce off the ground and arrive at airplane "B" a short interval after pulse traveling the direct route. Knowing the altitude of airplane "A" (from its pulse spacing), and its own altitude, airplane "B" can determine the distance and closing rate of airplane "A" from the time delay between receipt of the direct and reflected pulses.

More Investigation Required

Bendix hopes to conduct further investigations of the basic technique, Dr. Morrell says, to determine its feasibility. Lack of bearing information appears to limit technique's usefulness, but it might be combined with infrared bearing determining system or other techniques, to provide automatic collision warning.

Radio Corporation of America reported that it is constructing a developmental model of an adaptor for airborne weather radar to evaluate feasibility of providing automatic warning of intruding aircraft within line-of-sight of the weather radar. Flight tests are expected to begin this spring.

Packard Bell Electronic Corp. also reported on a constant-bearing evaluator, small, lightweight device which could be used with any proximity warning indicator to assist the pilot in evaluating whether an intruder presents a collision threat. Device consists basically of a small tape recorder which records position of intruding aircraft on successive rotations of the infrared or radar scanner to determine which intruders are remaining on essentially a constant bearing, hence represent a collision hazard.

SHORTLINES

► Air France began its 1958 advertising campaign with 1,000 line newspaper advertisements. The French airline's magazine ads this year will use larger space units, more color than before. They will include full page ads in black and white and in four colors. The new campaign is being handled by Batten, Barton, Durstine & Osborn Inc.

► American Airlines will begin "Cap

tain's Flagship' service from Washington to Chicago on Feb 2 using Douglas DC-7s The new service will operate on a once-a-day basis for the roundtrip Sunday through Friday American's luxury planes are scheduled to leave Washington at 4 45 P M EST arriving at Chicago's Midway Airport at 6 15 P M CST The return flight is scheduled for 4 35 P M CST departure for arrival in Washington at 7 40 P M EST

► **International Air Transport Assn** reports that airline summer schedules for this summer will begin three weeks earlier according to timetable arrangements being prepared by IATA members Summer schedules will go into effect on April 1, rather than late April as before, and remain in effect until Oct 31 There will be IATA says, 20% more passenger seats available next summer because of the introduction of the new economy service across the North Atlantic scheduled to begin April 1 subject to government approval

► **Pan American World Airways** has asked the electronics industry if it can supply the airline with equipment that will make possible instantaneous answers to requests at its sales offices on six continents for space on flights anywhere in the world and then provide automatic ticketing for the passenger Pan American is asking for a machine that will confirm reservations six months in advance for seats and berths and automatically issue a ticket after quoting the correct fare—a process that now takes a sales agent several hours and about ten operations to accomplish Pan American also reports that transatlantic airline traffic between the U S, Canada and Europe in 1957 went over the million mark for the first time, with 1,003,000 passengers

► **Trans World Airlines** will schedule its low economy fare flights to Europe beginning April 1 between the U S and London, Paris, Frankfurt, Rome, Lisbon and Madrid The new fares subject to government approval, will bring the roundtrip fare to Paris to as little as $489 60, $68 40 less than the present tourist fare TWA will operate economy fare flights with Lockheed Super Constellation equipment

► **United Air Lines** on Jan 5 came within 2% of the volume carried on the peak day of 1957 The single-day post-holiday mark of an estimated 17,855,000 revenue passenger miles compares with 18,237,000 revenue passenger miles flown by United on Aug 29 From Dec 18, through Jan 5, the company carried 324,176 passengers 240,961,000 revenue passenger miles

AIRLINE OBSERVER

► Continental Air Lines led the way last week in requesting a 15% interim fare increase, with other airlines falling promptly into line. Carriers will stress that the financial emergency conditions which prevail throughout the industry and ask for the increase to protect them during the Civil Aeronautics Board's General Passenger Fare Investigation which may run through most of 1958 In the petition for a 15% increase, Continental president Robert Six pointed to the slow rate of progress of the investigation and said, "The airlines can't wait." Six said the increase is needed to attract investors' capital and meet rising costs. The Continental request asks for a 15% increase to be effective from Feb 15 until 30 days after the Board's decision in the General Fare Investigation

► **Threatened strikes against Eastern and American airlines by the Air Line Pilots Assn were averted last week by last minute agreements to meet with the National Mediation Board in a renewed attempt to reach a peaceful settlement As of late last week, Western Air Lines pilots had not set a date for the strike voted against the carrier which employs 263 members Eastern employs 1,465 pilots, American 1,541**

► **Civil Aeronautics Administration is initiating a changeover to double-channel-simplex communications providing one frequency for ground-to-air contacts and a companion frequency six megacycles higher for air to ground calls The program will be operated on a 'request basis' until July 1 when it will become automatic for ground stations to reply on 120 7 mc to any call on 126 7 mc**

► **Airline officials representing state-owned airlines in Eastern Europe met recently in Sofia to discuss means of improving airways facilities in their area Bulgaria, Poland, East Germany, Rumania, Hungary and Czechoslovakia were represented An Aeroflot official unofficially represented Soviet Russia.**

► **West Germany Lufthansa and Aeroflot have signed an interline agreement similar to those reached by Pan American, British European Airways and Air France with the Soviet state-owned airline Agreements call for an exchange of tickets between the carriers**

► **Nihon Express Co Ltd of Tokyo will study the U S. helicopter market with the view of purchasing a fleet for the transportation of passengers and cargo in Japan. Nihon, an organization similar to the American Express Co, organizes sightseeing tours throughout Japan as one of its many functions.**

► **Departments of Defense and Commerce have signed an agreement on air traffic control to permit joint use of military and civil facilities Objective of the agreement is to increase capability of each air traffic control function and prevent duplication of facilities and equipment The agreement makes clear, however, that "effective air traffic control and air defense systems must each normally maintain their separate identities, individual functional integrity and separate management"**

► **Civil Aeronautics Board public hearings began in San Francisco last week on the fatal accident involving a Pan American Boeing 377 which crashed in mid-ocean between San Francisco and Honolulu on Nov. 8 Factor likely to draw major attention is the discovery of excessive amounts of carbon monoxide found in 14 of the 19 victims recovered from the accident.**

► **International scheduled airlines carried 1,020,000 passengers in 1957 between the U S, Canada and Europe to pass the one million mark for the first time on North Atlantic routes, according to the International Air Transport Assn In a statement issued by Pan American World Airways, a total of 885 000 passengers reportedly used the scheduled airlines between the U S only and Europe in 1957 as compared with 738,933 passengers the previous year Westbound traffic on the U S Europe route amounted to 493,000 passengers, a 23% gain over the 1956 volume, eastbound traffic totaled 392,000 passengers, a 16% increase**

FIRST production Boeing 707-120 has angled horizontal tail surfaces, is shown equipped with sound suppressors (AW Dec. 16, p. 79).

Boeing Seeks to Lead Jet Age Market

FUSELAGE section of 707 is shown being joined to wing center section. Assembly is accomplished in six longitudinal sections.

BOEING says its experience in large swept-wing aircraft has yielded knowledge of the design factors which affect airline profits.

With 707s

By Richard Sweeney

Seattle—Boeing Airplane Co., first out with a production American jet transport, has designed a family of airplanes in its 707 series aimed at re-establishing the company at the top of the commercial market in the jet age.

Working toward this goal, knowing that the airplane's overall efficiency is paramount, Boeing has produced a design which, in addition to having better than required flight safety characteristics, will meet these airline operational criteria:

- **Minimum direct costs,** including ground handling and servicing as well as in flight operation.
- **Maximum reliability** in all systems.
- **Maximum maintainability.**
- **Maximum flexibility.**

Company has followed up with plans for maximum customer support in training and service, an area where it has been behind competitors in the past.

Experience gained in some 800 hr. flight test of the 707-80 prototype has been cranked into the first production 707-120, rolled out last month and flown before the end of the year (AW Dec. 30, p. 27).

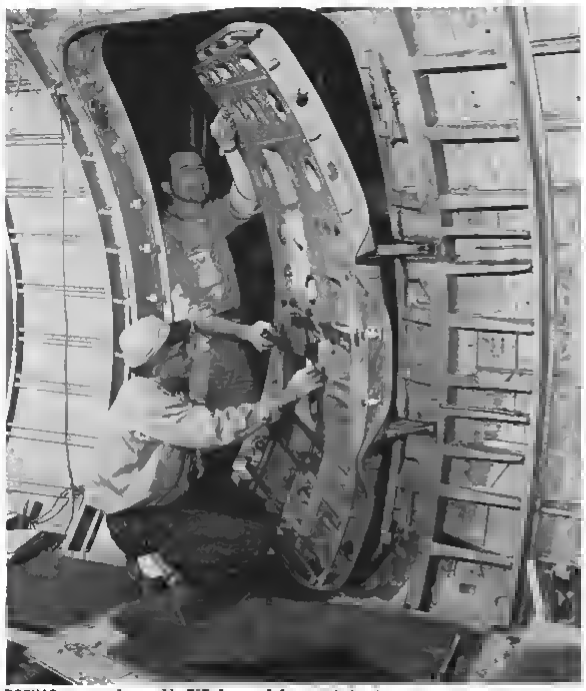
Aerodynamics, structures and systems have been integrated toward production of an airplane which is conventional yet refined: one which can be absorbed into airline operations alongside today's piston powered transports with, Boeing feels, much less trouble than has been expected in some quarters.

When jet transports first loomed on

GEAR trucks can "walk" over bumps, this should boost wing upper surface fatigue life.

BOEING 707-120 lands with flaps extended. Aircraft will require 7,000-8,000 ft. runways.

WINDOW reinforcing frames and forgings: window frames in pilot's compartment are two-member construction for fail-safe provisions, forgings are used around passengers' windows.



BOEING personnel assemble 707 door and door joint structure.

the horizon, Boeing conceived a combination airplane for military and commercial applications, feeling that advances and standards surrounding one would accrue toward profit in the other. However, powerplants were the problem.

By early 1950s, engine advancements made the combination airplane technically and financially (original cost as well as operation and upkeep) feasible.

Other Considerations

Other considerations entered the picture as feasibility became apparent. These included the realization that the first airplane would have to be a good one and that, due to tremendous initial investment coupled with expected earning power of jets, airlines no longer would tolerate mechanical inconveniences and their attendant economic penalties.

On the other side of the picture was the increase in desk and laboratory analysis in systems, components and parts to insure real reliability before incorporation into the design, this being a result of the higher costs and greater complexity of modern high speed jet aircraft. Growing concurrently were new standards of development requirements and flight test programs which became mandatory with the different operating envelopes and economics of jet airplanes.

Boeing evolved a design—built around the J57 engine basically rated at 10,000 lb dry static thrust with design gross weight on the order of 250,000 lb and a wing area of 2,400 sq ft—which could operate profitably on stage lengths of transcontinental length.

To bracket the transport market, Boeing realized the need for an airplane capable of stage lengths 1,000 mi greater than those of the first airplane, for transoceanic routes. Working toward a realistic airplane base capable of hauling a financially profitable full payload, the company expanded the design to the 707-320 class, with 2,900 sq ft of wing area, bigger engines and a 300,000 lb gross weight. This was done, Boeing says, rather than trying to paper-work the 707-120 series up to this capability, a marginal procedure at best.

Boeing operations data show the 707-120 will be capable of operating from 7,000 to 8,000 ft runways, while intercontinental-class airplanes will require 8,500 to 10,000 ft. Both aircraft, company believes, will have terminal area compatibility with current piston-powered transports. One possible real problem area, Boeing indicates, will be the difference in en route speeds of jets and pistons.

Designers of the 707 have bent all possible efforts to beat "Murphy's" three laws: (1) If it can fail, it will, (2) If it can be hooked up backwards someone will do it that way, (3) All failures occur at the worst possible point in time and space.

Boeing feels its experience in large swept-wing airplanes has given it knowledge concerning the small design refinements which can make the difference between large profits, slim ones or no profits for airline operators.

An example of this is in the use of a 35 deg sweep for the best possible combination of characteristics. Another is aerodynamic flight controls which, despite sweep angle, keep aircraft fully controllable in all flight regimes where completch asymmetrical flap conditions could be induced, according to Boeing.

Even with the experience of the B-47 and B-52 behind it, Boeing still ran into many problem areas with its 707-80 prototype airplanes, problems which did not show up in wind tunnel testing despite the extensiveness of this work which preceded the design.

Aerodynamic Design

Gathering extensive experience in large swept-wing jets through its bomber programs and realizing jet transports eventually would follow, Boeing in 1947 and 1948 did preliminary work on a commercial jet configuration, accenting the economic aspects.

Very little was done on the physical layout characteristics assumed were taken from contemporary bomber programs.

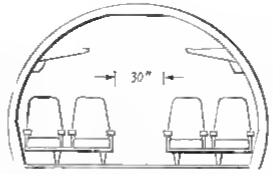
During 1949, realizing that airlines knew little of jet operations and that extensive education work was required, Boeing began a study which culminated in a fairly comprehensive operational performance report. Issued early in 1950, the report covered not only projected landing and takeoff distances but many other facets and variables of jet operations which would affect airline operations.

Airplane assumed in this report had aerodynamics largely based on the B-52, used four J57 engines, had a 2,500 sq ft wing with a 35 deg sweep. Using this airplane, Boeing had its first real chance to study such aspects as high vs low wing location and to investigate bicycle and tricycle landing gears.

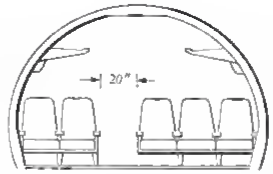
Since the performance analysis was well received, Boeing proceeded to refine the design, make a wind tunnel model and designate the project 473-60. The resultant aircraft differed from the performance analysis airplane in that a smaller 2,300 sq ft wing was used but it still retained B-52 characteristics. Landing gear evolved was fuselage mounted, giving the main gear a narrow tread. Two versions were set: a 135,000 lb domestic airplane, and an

707s No. 4, 5 and 6 are seen at Renton, Wash. plant. Note fuselage frames and structural members, designed to stop crack propagation. Fuselage frames are spaced 20 in. apart.

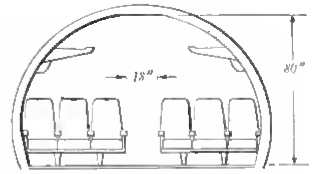
LANDING gear trunnion mounting box structure on rear spar, left wing is shown above. Note heavy upper and lower forging. Wing undersurface (below), shows built-up structure which Boeing uses rather than integral stiffening.



Boeing 707 four abreast luxury seating



Boeing 707 five abreast standard seating



Boeing 707 six abreast tourist seating

nerwater configuration at weights up to 180,000 lb. to carry 60 passengers.

While these plans too seemed well received, Boeing engineers became dubious. They were unsatisfied with landing gear configuration, also felt airlines still were not ready for jets.

At this same time, effort was being made to bring C-97 design up to date, using either turboprops or advanced piston engines. Several configurations were evolved, one of which used an 18 deg. swept wing, T34 turboprop engines. Another had a 35 deg. swept wing, J57 powerplants and the C-97 fuselage.

'Advanced C-97'

Evaluation of these resulted in the "Advanced C-97," using four turbojets. Wing had a 25 deg. sweep which seemed to satisfy landing gear geometry by calling for gear suspended from the wing behind torsion box but retracting into fuselage, a requirement which the 18 deg. sweep was not able to meet. The 25 deg. sweep also promised desired Mach number characteristics while retaining the advantages of less than 35 deg. sweep for transport application.

After some $200,000 had been spent in direct engineering costs and it became clear USAF would not be able to underwrite development, the airplane was abandoned.

With both early model 473 and 'Advanced C-97' dead, engineers took a fresh look at overall design. Landing gear needed better layout, and fuel capacities were judged insufficient for the design to stay with competing airplanes which would have followed it closely. More had been learned about swept wing aerodynamics, especially the relationship between sweep thickness ratios.

A new project was started, Model 367-80, today's 707-80 airplane, and the decision was made to build a prototype with company funds.

Airplane had a 35 deg. sweep, new thickness ratio philosophy and landing gear geometry which satisfied requirements. And it was thought that by the time the airplane was out, tested and ready for sale, the airlines would be ready. The airplane also had real potential for military tanker-transport application.

Final aerodynamic changes were made in this design. Dual pod, used in all work up to then, was eliminated after USAF Directorate of Flight Safety Research Records at San Bernardino indicated failure of one engine in a dual pod usually resulted in damage to the other engine.

Decision had been made to build a prototype to lighter gross weight than that projected for any production articles, thinking being that necessary extra weight could be added in production design, would use up extra margins inherent in any new design.

Realizing that aerodynamic development in the high-speed regime of jet transports is extremely competitive, Boeing has done extensive flight test work on the 707-80, has made basic philosophy changes where indicated.

Basic wing flight test results have been good, closely following predicted performance. Flight controls have undergone considerable refinement.

It also became apparent that a wider fuselage cross-section was indicated, but decision was made to incorporate this change in production versions so as not to slow down prototype development.

Structural Design

Carrying out optimization in structural design of the 707, Boeing worked out the best combination of sweep angle, thickness ratio and structure to yield a non-gust critical airplane.

A wide variety of materials is used, each chosen to match a particular application requirement.

Additional structural standards are:

- **High residual strength** after some damage.
- **Slow rate of crack propagation.**
- **Easy inspection and maintenance** of structure based on expectancy of high utilization rate and life expectancy considerably greater than that of present transports.

Two spar wing was designed at pre-selected wetted area, with desired maximum lift-drag ratio. Weight distribution accomplished a flexibility damping.

Relief of gusts through sweep angle

Boeing 707 Basic Data

	707-120	707-220	707-320	707-420
GENERAL DIMENSIONS				
Wing span	130 ft 10 in.	130 ft 10 in.	142 ft. 5 in.	142 ft 5 in.
Tail span	39 ft 8 in.	39 ft 8 in.	45 ft 8 in.	45 ft 8 in.
Length overall	144 ft 6 in.	144 ft 6 in.	152 ft 11 in.	152 ft 11 in.
Height overall	38 ft 7 in.	38 ft 7 in.	38 ft 8 in.	38 ft 8 in.
Wheel base	52 ft 4 in.	52 ft 4 in.	62 ft 4 in.	62 ft. 4 in.
Tread	22 ft 1 in.	22 ft 1 in.	22 ft 1 in.	22 ft. 1 in.
FUSELAGE				
Length	138 ft 10 in.	138 ft 10 in.	145 ft 6 in.	145 ft 6 in.
Maximum width	12 ft 4 in.	12 ft 4 in.	12 ft. 4 in.	12 ft 4 in.
Maximum depth	14 ft 2.5 in.	14 ft 2.5 in.	14 ft 2.5 in.	14 ft 2.5 in.
Passenger capacity				
First class	124	124	131	131
Tourist	150	150	162	162
CARGO COMPARTMENTS				
Volume forward hold	700 cu. ft.	700 cu. ft.	800 cu. ft.	800 cu. ft.
Volume aft hold	900 cu. ft.	900 cu. ft.	900 cu. ft.	900 cu. ft.
WEIGHTS AND PERFORMANCE				
Maximum gross weight	248 000 lb.	248 000 lb.	296 000 lb.	296 000 lb.
Maximum landing weight	175,000 lb.	175 000 lb.	195 000 lb.	195,000 lb.
Maximum payload	42,750 lb.	42 000 lb.	40,000 lb.	40 000 lb.
Maximum fuel	113 000 lb.	113 000 lb.	149,500 lb.	149,500 lb.
Cruising speed	591 mph.	585 mph.	605 mph.	595 mph.
Engines (4)	P&W JT3C-4	P&W JT4A-3	P&W JT4A-3	99 Conway Mk. 505

considers the fact that greater sweep angles cause lower basis lift curve slope, lower lift increase with Mach number, greater alleviation (unloading) due to wing bending and greater alleviation due to increased flexibility a longer elastic axis

Proper thickness ratio selection also influences bending characteristics, elasticity and stress levels

Design Advantages

Boeing feels designing to non-gust critical standards has yielded margins in many places These advantages are cited

- **Capable of high speeds** over a wide range of altitudes 707 is placarded below its abilities at low altitudes yet strength margins are such that exceeding limits will not be immediately catastrophic
- **Experience** has shown airliners encounter higher velocity gusts in unusual weather than are planned for in Civil Air Regulations (which are based on probability theory) Gust relieving characteristics of 707 sweep angle are such that greater gust strength will constitute major safety increase Boeing says
- **Lower stresses** in gust relieved 707 wing should provide major increase in time span before first cracks due to fatigue appear
- **For an equivalent level** of passenger comfort that is passengers feeling the same level of load factor in turbulence, the non gust-critical 707 will be able to traverse turbulent area at higher speeds than other aircraft or if speeds are reduced passengers will feel much lower level of gust load factor

Aircraft structures are damaged many ways during service life by foreign objects in flight and ground taxi, fatigue corrosion improper installation of equipment and parts of structure, plus others

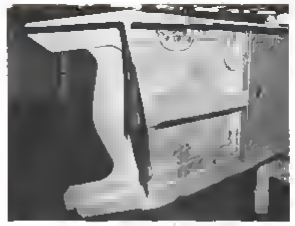
To offset this Boeing designed the 707 to sustain damage yet maintain high safety level by using multiple load path (redundant structure and multi-member crackstopper construction

Where deemed necessary extra structural weight was added in specific areas to obtain best fail safe characteristics

Materials Selection

Design base was selection of materials according to requirements In all fuselage parts subject to tension loads from pressurization—on wing underside wing spars, empennage skin and spars—24ST is used because while other alloys have higher initial properties, this material retains a greater percentage of its strength after some damage giving higher strength level after damage or cracks

In areas where tension stress is lower,



WING SPAR attach point forging gives rigidity to wing Large forging saves weight

such as wing upper surface 78ST is used to take advantage of high compression strength Wing stiffeners are 75ST

In materials crack propagation tests, made on specimens where a crack was induced, cycling was at a load rate considered average for airline operation and was continued until a 2 in crack length was attained This indicated that 24ST has approximately three times the endurance of higher strength alloys, reinforcing Boeing's belief that 24ST is best in critical areas provides maximum assurance of crack detection before airplane safety is jeopardized

Wing Stiffeners

On the wing underside, stiffeners are spaced approximately 7 in. apart, and at CAA fail safe load factor values cracks which may occur would grow at a very gradual rate up to almost the entire distance between stiffeners before any inclination to progress rapidly appears Stiffeners provide against rapid propagation acting to insure that visual inspection will catch a crack before it progresses beyond safe limits

In addition, chordwise panel construction provides for safe load carrying by adjacent panels at strength levels above those specified in CAA fail safe standards should one panel fracture completely At each skin splice a structural member heavy enough to stop any crack is provided

Fuselage frames are spaced 20 in apart again crack propagation would be slow until frames are reached Frame reinforcing acts to stop crack propagation and prevent catastrophic failures Structural members which can carry the entire pressure load in case the skin should fail are provided at each fuselage frame Members also are designed so that a high safety level remains should damage occur from puncture by flying objects

Structural specimens of both wing and fuselage have been development-tested—specimens such as wing underside cutouts fuselage parts where frames were severed, and where two adjacent bays of skin severed simultaneously

Window frames in pilot's compartment are two member construction for fail safe provisions while forgings are used around passenger compartment windows

Conservative design factors were used in multi member section design as insurance that safety endurance will remain in case one member fails, and against immediate capacity loads being imposed on surviving member at failure of the other

Additional fatigue cognizance is taken in main landing gear design While a four wheel truck helps distribute footprint loads to where they can be borne by existing runways and taxiways a multiple-wheel system helps reduce negative loads on wing during taxi Load factor reduction accomplished by truck's ability to "walk" over bumps will Boeing feels materially boost wing upper surface fatigue life Gear configuration also will increase passenger comfort by reducing humpiness

Using Miner's cumulative damage theory, 707 design also takes into consideration the fact that little is known of clear air turbulence, and has made provisions for this

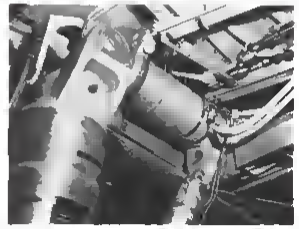
Acoustic vibration resistant structure has proved a section-by-section development Experience has been a guiding factor since no classical engineering theory is available Boeing feels design of acoustic vibration-resistant structure still is more art than science

Honeycomb Structure

Honeycomb has been used extensively throughout wing and flap and trailing edges of these to reduce maintenance of this secondary structure as well as provide structural integrity In other areas where indicated, bonding has been used

Other design measures include elimination of all possible stress raisers in acoustic vibration areas where structure is kept as passive as possible

Since acoustic vibration falls across parts of spectrum other than those which are of primary concern in the airport noise environment problem,



LANDING gear mounting is uncomplicated in design yet stressed for high loads.

How Douglas Fabricates High-Temperature Silicone-Glass Laminated Ducts

. . . WITH DOW CORNING SILICONE RESINS

Douglas Aircraft needed a material that could withstand high temperature and vibration for air ducts in the giant C-133A military turboprop transport. The material also had to be light in weight, economical, and easily fabricated into complex shapes. Douglas found the answer in silicone-glass laminates. Dow Corning silicone resins provided all the required properties, plus resistance to moisture, corrosion, and fungus. The finished laminates solved a costly design problem, being much less expensive to fabricate than metals of comparable strength. Here's how Douglas makes ducts in its own shops using glass cloth that has been pre-impregnated with Dow Corning silicone resin.

TYPICAL PROPERTIES OF LAMINATES MADE WITH DOW CORNING SILICONE RESIN

Flexural Strength, psi	
at room temperature	40,000
at 500 F	15,000
at room temperature after 200 hours at 500 F	38,000
at 500 F after 200 hours at 500 F	17,000
Dielectric Constant	
at 10^6 cycles	4.21
at 10^{10} cycles	4.30
Dissipation Factor	
at 10^6 cycles	0.0023
at 10^{10} cycles	0.0066

Write for FREE BOOKLET containing properties and applications of Dow Corning silicone-glass laminates. ADDRESS DEPT. 091b.

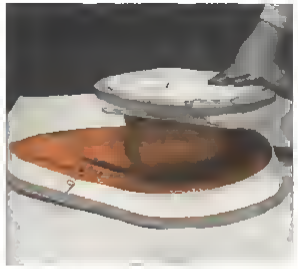
First in silicones

Dow Corning CORPORATION
MIDLAND MICHIGAN

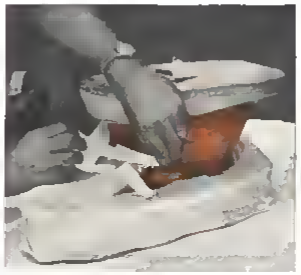
ATLANTA BOSTON CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON D. C.
CANADA: DOW CORNING SILICONES LTD TORONTO GREAT BRITAIN: ALBRIGHT & WILSON (MFG) LTD LONDON FRANCE: ST GOBAIN PAR S

METHOD IS SIMPLE, ECONOMICAL:
First, a plaster mold is coated with a suitable release agent.
Then . . .

1. Layup is made on the plaster form. Hot air gun softens the resin for better drape. Tacking iron compacts and adheres fabric, removes any wrinkles.



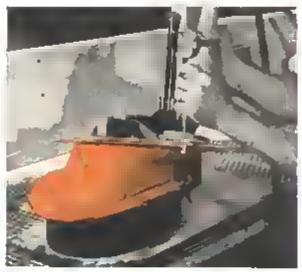
2. Layup is complete . . . note how snugly the fabric fits the contours of the mold.



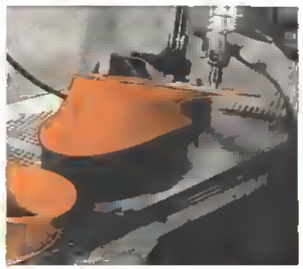
3. Bleeder cloths are applied and vacuum inlet is placed. The bleeder cloth permits even distribution of vacuum, resulting in smooth, uniform part.

4. The assembly is encased in PVA vacuum bag. Operator checks for full and uniform vacuum. Mechanical vacuum pump is used.

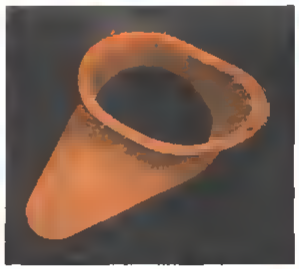
5. Whole assembly is now placed in oven. After initial cure of 2 hours through 325 F, the bag is removed. An after-bake of 16 hours through 500 F completes the cure. Plaster mold is removed with air hammer.



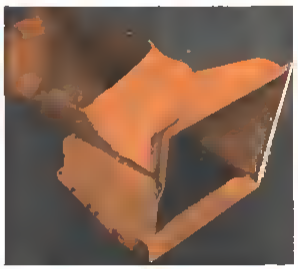
6. Cured part is placed in the jig where the edges are trimmed and smoothed with air grinding wheel to fit template.



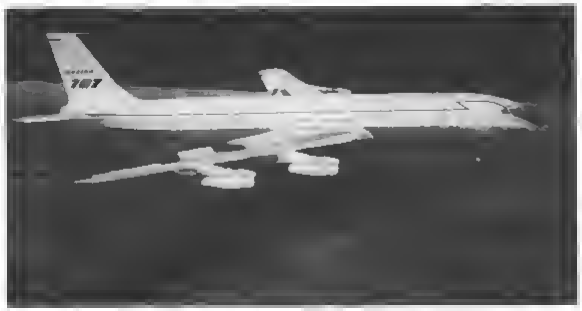
7. Same jig and template are used to drill mounting holes on flange. The laminate is easy to machine.



8. Finished part illustrates the smooth, accurate reproduction possible using silicone pre-impregnated glass cloth and the bag molding technique.



9. Complex parts with sharp angles, varying thicknesses and many joints can be produced quickly and economically using Dow Corning silicone resins. Strength-weight ratios are excellent.



SPOILERS, in up position, act as speed brakes during 707's landing roll-out.

Boeing suppressor development has been geared to both approaches

In addition, since sound actually results in large alternating high frequency loads upon structure, Boeing is working at both use of sound suppressors to reduce the sound pressure levels and designing structure to withstand higher pressure levels of unsuppressed engines

Test Advantage

An area where Boeing feels it has an advantage is in testing, since it has B-47, B-52, 707-80 prototype and KC-135 experience to draw upon

Basic divisions of structural tests planned are:

- **Flight tests** to check air loads
- **Static tests** to check ultimate strength
- **Cyclic tests** to check fatigue resistance
- **Fail-safe tests** to check residual strength

Normal procedure of joint development testing, fail-safe load testing and pressure testing was accomplished during design and development of wing, fuselage, empennage and secondary structure as well.

Tests on the KC-135 provided additional data on strength in many places due to similarity of the airplanes.

In connection with the 707-120 and KC-135 relationship, the Civil Aeronautics Administration has allowed Boeing to submit KC-135 test data in the 707 program, where applicable. However, proof of applicability is left for Boeing to establish.

Static test data from KC-135 program has also indicated areas of extra margins in 707 design, a good yardstick of growth potential.

Boeing has placed great emphasis on 707 systems integration and compatibility to achieve high order reliability. Various systems are powered according to what the company feels is optimization of all factors.

An example is flight controls using

- **Pilot manual force** for primary surfaces movement through aerodynamic tabs
- **Hydraulic power** for rudder boost, spoilers
- **Electrical actuation** for horizontal stabilizer positioning jackscrew normal elevator trim tab adjustment.

Controls are extensively modified from first 707-80 systems in aerodynamic sealing and mass balance as well as source of power. This results from flight test experience with the prototype.

Boeing used ailerons on B-47, spoilers on B-52, has combination lateral control system on 707. Narrow span, deep chord inboard ailerons, located between inboard and outboard flap have aerodynamic actuating tabs almost their full span, provide for small lateral corrections.

Conventional Ailerons

Conventional ailerons at wingtip remain fixed in normal flight, become operational by mechanical linkage to inboard ailerons when flaps are extended.

Spoilers combine with inboard ailerons in normal flight regimes as lateral control augmentation according to roll rate specified by pilot control wheel. Extended as speed brakes, spoilers still work in lateral control system through a differential.

Although rudder displacement still is primarily through aerodynamic tab, hydraulic boost has been added to obtain full travel at low speeds and get best control characteristics throughout an engine-out-at-takeoff situation. Boost comes into play at 6 deg. rudder deflection either way, which is approximately one third of full 18 deg. travel each way. Provisions have been made so that its surface responds to tab signal from pilot's pedals, hydraulic fluid bypasses actuator, if not, system shifts to power operation.

Horizontal stabilizer moves electromechanically. Electric motors, through a gear box, move ball bearing screw according to signal from a pilot wheel thumb button. Separate electrical motor is connected to same gearbox ball bearing screw which is operated by autopilot correction signals.

Aileron and rudder trim is by cable and drum from cockpit control wheels and a cable-drum system also is installed for elevators use.

Working from basis, proven Pratt & Whitney Aircraft JT3 (J57) turbojet, engineers had excellent base for systems design in that engine performance and characteristics as they affect accessories were well known.

Hydraulics are designed around utility (normal operating) and auxiliary (emergency) systems. Both are 3,000 psi. have flareless fittings, use 8 hard-thin wall (less weight) tubing, utilize Skydrol fluid.

Utility system operates from two variable volume (40 gpm. rated) pumps on No. 2 and No. 3 engines. Auxiliary system operates from electrically driven 3 gpm. capacity pump. Both systems are in constant operation, work from separate fluid supplies. Manifolding precludes connecting systems in flight, although this can be accomplished on the ground for test.

Airplane's spoiler system has outboard-inboard operating configuration with utility hydraulic system powering outboard units, auxiliary system powering inboard sections. Inboard spoilers and rudder working off 3 gpm. system have slower rate of movement than utility system powered equipment.

Spoilers have gear differential follow-up to provide position feedback signal to control valves. No synchronization between sides is incorporated, since all control valves operate from a common signal valve although they have different power sources. Emergency provisions enable inboard spoilers to be raised at landing, helping get aircraft's weight on the wheels as quickly as possible.

Flap Power

Flaps have one hydraulic motor for inboard sections, another for outboard. Left and right inboard flaps are mechanically bussed together with motor driving a torque tube through a gear box. Outboard flaps are moved similarly. Flaps employ same design signal valve as spoilers, incorporate a hydraulic flow limiter to equalize travel rates, insure same ultimate travel.

Flaps can be extended and retracted electrically in emergency.

In addition to outboard spoilers and flaps, utility hydraulic system operates landing gear doors, gear extension and retraction, main brake system, nose wheel steering.

Hand crank lowers landing gear in an emergency. Three sockets, one for each gear, are located close together in cockpit. Cranking releases landing gear door operating cylinder integral uplock, which requires no hydraulic pressure to keep lock in place, then releases gear uplock. Gear gravity-falls into trail, more cranking puts gear into down and lock position. Gear uses down past-center lock normally and in emergency.

Each gear requires approximately 20 sec. to reach down-and-lock after crank is first inserted in socket.

Normal airplane hydraulic braking system has anti-skid provisions.

Emergency braking is pneumatic, with pilot skill in handling a factor in overall effectiveness. Bottle will provide for seven full applications of 50% normal braking capacity, fully released after each application. Bottle is independent unit, not rechargeable in flight.

OUTSIDES of top 90 deg. of engine pods have titanium skin, remainder is aluminum alloy

Avionic System

New electrical system for 707 has two outstanding features aimed at reliability upgrading. These are:

- **New Westinghouse** brushless a.c. generators
- **All electrical** system control protective circuits are done in solid state, eliminating usual electromechanical units formerly accomplishing this task.

Three basic electrical systems are offered 707 customers. Two are 120 kva., one is 160 kva., the higher power unit required for those customers having electrically driven cabin air conditioning system instead of plane's usual "bootstrap" system.

Two 120 kva. systems make use of three 40 kva. generators and four 30 kva. generators. Difference arose from some customers desiring to be able to dispatch an airplane if one generator was inoperative but system still would sustain normal operations power.

On all systems generators operate in parallel. Generators are driven at 6,000 rpm. by Sundstrand hydraulic constant speed drives which hold generator speed to specified level at engine accessory drive pad speeds ranging from 3,600 to 7,000 rpm.

'Essential' Power

Basic in system design was Civil Air Regulation specification of "essential" electrical power requirements to maintain straight and level flight and to safely complete flight in case of emergency.

Essential loads in 707 total roughly 30 kva., making one generator capable of meeting an emergency.

Generators are connected into plane's system by a normal load bus. On each generator between the generator and the normal load bus, there is an "essential" a.c. bus. A four or five position selector in cockpit (three or four generators, ground power) insures that one generator always has the essential bus tied in, so that no interruption of essential power will occur in a general system failure.

Normal requirements d.c. in 707 is provided off a.c. system by 50 amp. transformer rectifiers. No d.c. generators are used. In emergency situation, required d.c. power also is obtained by transformer rectifier which is tied directly to the essential a.c. bus.

FLIGHT deck includes instrument panels and control pedestal, lower center, circuit breaker panel, overhead, navigator's station with Loran receiver, left, engineer's station, right.

Generator Design

General system design provides four independent and isolated unloaded generators to select from for essential power source when generator circuit breakers all are open. The essential a.c. bus can be connected to any generator while that generator's normal load bus is disconnected through selector switch.

Civil Air Regulations specify that in case of cockpit smoke (electrical system problem), instruments necessary for straight and level flight remain operative.

In addition there are requirements to be met under Civil Air Regulations specifying the essential loads for safe flight completion after two generators have failed.

In the 707, while the crew is checking out the system malfunction, part of the safe flight completion equipment specified is not operative, but becomes so after problem is located, isolated and remaining generating units are returned to load bus.

The various buses, the loads they

carry in emergency conditions are

- **Battery bus**—Engine ignition, electrical system controls, fuel valves, certain critical indicator lights.
- **Essential bus, 28 v. d.c.**—Battery charger, fuel dump, fire warning and extinguishing, essential cockpit and cabin lights, flare release, hydraulic shutoff, engine fuel valves, essential radio, windshield wipers.
- **Essential bus, a.c.**—Autopilot, essential radio bus, captain's pilot heater, essential d.c. transformer rectifier unit, essential lighting, cargo fire detector.

Civil Air Regulations-specified loads to be carried for safe completion of flight after loss of two generators, window anti-ice, engine anti-ice, empennage anti-ice, fuel boost pumps, d.c. system stabilizer trim, auxiliary hydraulic pump, emergency flap drive, essential radio and navigation equipment and exterior lights.

Battery for 707 is 36 amp hr. Charging is from two sources at all times, from essential bus transformer rectifier, and normal d.c. system. Either one alone will keep battery fully charged against its load, recharge it from partial discharge condition against load as well.

Transistorized Circuits

Electrical system control protective circuits make use of transistors, Zener diodes, plain diodes, eliminating devices like over-voltage relay and dashpots. Transistorizing the controls yielded finally, a unit of same weight and volume as conventional unit yet capable of many more functions.

Use of Zener diodes, which have a very stable breakdown point, gave highly reliable reference point for system voltage monitoring and circuit breaker disconnection after breakdown occurs.

Resistance capacitance networks now provide desired time delay in system.

In addition to normal electrical system work, Boeing has done extensive development in electronics provisions for 707, and electrical-electronic systems compatibility.

Antennas have received a great deal of attention, along with couplers, Loran and low frequency radio, lightning protection.

Much has been done with autopilot systems. Complete analog analysis has been made of various equipments and, in each case, theoretical inputs were replaced by hardware in the hookup as quickly as hardware was made available.

Complete electronic and electrical system mockups have been built from production drawings. Cable lengths and other runs are accurately reproduced. Systems are tested individually, then worked together in their operational environment. Equipment cooling tests are conducted, a major effort is directed at discovering problems while they can be fixed in design stage rather than on production airplanes.

Pressurization of 707 is provided by three turbocompressors, driven off early stage engine compressor bleed air. Only three are used they provide necessary normal and emergency system capacity as envisioned by Boeing. Turbocompressors are located on top of engines with air intake at cowl lip. Engine pod mounting pylons were reconfigured from original shape to accommodate compressors.

Turbocompressors each have own controls, and again a thorough study of equipment and control system for compatibility, long life and reliability was made. Controls are hydromechanically operated.

Air Conditioning

Basic air conditioning system is air cycle (bootstrap) with an alternate vapor pressure (electrically driven) available.

Air cycle system operates with ram air going through a heat exchanger, compressor, another heat exchanger, turbine water separator and into cabin. Temperature control directs ram air into either heating or cooling duct according to requirement.

Air distribution system puts some air between each fuselage frame from underfloor main duct, with continuous cabin outlet insuring low noise level. Thermal insulation is provided between heat passage and wall next to passenger.

System flow is 3,200 cu. ft./min. Individual temperature controls are electronic, give signal for desired temperature air to individual temperature control valve. Individual eyeball outlets are provided.

Ground air conditioning operations are provided for.

In system cabin air is passed through electronic gear just before being dumped, and exhausting is such that an attempt is made to gain thrust in the cycle. Three pneumatically powered outflow valves are used.

Cabin pressure controls, joint AiResearch-Boeing development, yield isobaric control of cabin altitude in range of −1,000 ft. to +10,000 ft. except as limited by 8.6 psi differential. Cabin sustains 7,000 ft. level at 40,000 ft. pressure altitude.

Two of the three compressors are sufficient for the system under normal operating conditions.

At 30,000 ft., one compressor output can provide acceptable differential, approximating a 10,000 to 12,000 ft. cabin pressure altitude.

Boeing says concerning leakage increases, that three compressors can sustain the 7,000 ft. cabin at 40,000 ft. with 2 sq. in. hole.

In case of pressurization problems, pilot receives an audio warning when cabin altitude exceeds 10,000 ft. with signal varying according to the rate of rise, indicating degree of the problem.

Boeing calculates that if a problem arises such as blowout, pilot has 130 to 140 sec. to get the airplane down to at least 18,000 ft. where life can be sustained, disregarding oxygen provisions. Airplane performance accomplishes this easily.

Boeing says that under conditions of a window blowout, which yields a hole approximateing 100 sq. in., cabin will decompress in 30 to 40 sec.

When cabin loses pressure and altitude reaches 14,000 to 15,000 ft., oxygen masks pop out of overhead pods. Gaseous oxygen system is constant flow to rebreather type mask, which will have a one liter reservoir bag. System is modulated to provide sea level oxygen equivalent at a breathing rate of 15 liters/min.

Flight crew has separate oxygen system which has provisions for one member being on oxygen at all times.

In passenger oxygen masks, Boeing says effort is being made for standardization between Boeing, Douglas and Convair for one mask as a passenger comfort measure and to eliminate necessity for learning how to use three types of mask.

Mask design will be a universal-fit, will be such that mask is effective when just held to the face without being fastened by straps or other attachments, although attaching provisions will be made.

Another Boeing design factor is that after mask pops out, any movement of the line will trip small actuating lever which will start oxygen flow. Lines are sufficiently long to reach children lying in seat.

Four mask spaces will be provided per pod. Boeing will provide one mask per seat, beyond this it will be up to the customer for additional mask provisions.

Fire Provisions

In design of 707 power packages much attention has been paid to fire provisions, including extensive tests at CAA Technical Development Center, Indianapolis, Ind., in cooperation with CAA and USAF.

Pod and pylon design has titanium skin used 45 deg. down each shoulder from top center to pod, stainless steel and titanium in fire blocking panels in pod and pylon.

Outside of top 90 deg. of pod is done in titanium skin, remainder is aluminum alloy, with Boeing feeling that it would be better for a fire to burn its way through than try to contain it.

Although high temperature materials are used in these sections, through which engine bleed air is piped for

wing thermal anti ice, it still has been Boeing policy that air off engine is not allowed to exceed 450F at any point

In the fire tests Boeing has made sure that engine lubricating oils will not ignite alone, even when injected onto tailpipe When JP-4 was added as a torch, oil would ignite, but fire would go out

To sustain combustion, a 3 to 4 gpm glow of fuel and sparkplug was used as a torch for up to 40 sec., and in the rear section, on tail pipe, burning would continue

Testing for an uncontrolled fire condition, fuel at the rate of 2 to 3 pints/min up to 5 gpm for 6 min was used However tests failed to produce any fire in the forward compressor section, ahead of engine firewall In these tests, oil lines were sheared and oil tank was emptied in a 27 sec dumping Present configuration has no fuel lines in forward section, insuring against fuel fire possibility there

Uncontrollable Fire Test

Additional testing of uncontrollable type fire yielded results showing that after a 9 min fire, engine continued to run, was brought back to its power setting which preceded the fire which was 90% of normal sea level thrust

Testing was accomplished with 165 mph air flow, oil preheated to 250F and ambient air temperature of 75 to 85F

Fire detection system is Kidde continuous type which has temperature sensitive wire wrapped around all parts in fire areas System serves dual purpose of fire indication as well as overheat warning, additional measure of protection for pod and strut

However, a unit type detection system is being incorporated for one customer

Fire extinguishing uses four bottles of freon 13, located in rear section of inboard pylons Manifolding sends it to areas of use System has high discharge rate of 1 to 2 sec into nacelle. Agent is dumped into accessory section, where it was determined to be most needed in case of fuel or oil fires

Fuel System

Fuel system has each engine feeding off its own tank Tanks are labeled according to engine i.e., No 1 main feeds No 1 engine etc In addition, small reserve tanks are in wing tips a large tank in wing center section

No 1 and No 4 mains hold 2,333 gal, 16,165 lb of fuel each, No 2 and 3 mains hold 2,283 gal, 14,839 lb each, wing tip reserves have 434 gal, 2,821 lb each, and wing center section has 7,306 gal, 47,489 lb Plane's total internal fuel capacity is 17,406 gal, 113,139 lb

Fuel flows from center section tank into other mains through a pressure override system instead of transfer Center section tank incorporates 35 lb pumps, while mains have 15 lb pumps Check valves prevent backflow into center section tank Center section tank pumps can be allowed to run dry since they will put out about 1 to 2 lb of air in this condition, which is insufficient to pass into mains against the 15 lb fuel line pressure from these tanks' pumps In addition, 5 lb check valves are installed on center tank

Fuel system incorporates 50% ram air pressure into tanks according to CAA regulations

Wing tip reserves are manifolded into mains, gravity flow initiates at certain tank levels

Entire system incorporates CAA required crossfeed provisions Double pumps also are provided, and one pump can supply the system, putting fuel to where each engine's own pump can take over load

Wing fuel intertank lines are metal to metal rigid tubes are at wing's center of flexure where movement is least

Fuel dumping provisions have dump valves (operated off essential 28 v dc bus), are located behind main (rear) wing spar Dump tubes drop approximately 2 ft below wing, fuel gravity flows out

Refueling provisions are at one location between engines on each side with a total of four receptacles for pressure system Shutoffs are hydraulically actuated by weight at preselected levels Refueling rate is 50 psi at 1,500 gpm or approximately 10% of tank capacity per min, overall rate approximating 10 min per tank

Slow closing shutoff valves are used to prevent surge back into refueling equipment

In the refueling ports, lights are incorporated which come on when desired fuel quantity is reached Quantity can be preset from control in pilot compartment and when light goes on fuel is shut off As a backstop pounds-in tank dials also are located at refueling ports

Tanks are manifolded together to accomplish refill of all tanks from four ports

Standby refueling provisions have a conventional wing upper surface 3 in tank openings Center section tank opening is on right wing between landing gear rib and wing-fuselage fairing

Main and tip reserve tanks are integral while center section tank is of bladder cell type drained and sealed

Vent System

Vent system uses stringers blocked off at bottom to yield a square tube Some round tubes are used in crossover and provisions have been made to prevent fuel surge back through vent system

Pumps and valves in fuel system are housed in small receptacles within tanks Removing cover plate shuts off a manual valve into this receptacle so that only the few gallons in the receptacle are lost if equipment must be replaced instead of having to drain entire tanks Only exception is dump valves which must have minimum possibility of interference

Concerning fuel surge in tanks ribs have served effectively to block lateral fuel movement and no longitudinal surge problems have yet shown up in 707 80 or KC-135 flight tests, even in rolls

Water system for 707 has an integral keel beam tank with two electrically driven pumps one for each side delivering water from tank to engine where engine pump raises it to required pressure

Water tank which is run dry on takeoff is outside the pressure and insulated hull Approximately 740 gal of water are carried used at a 3-1 ratio

Combustion all pneumatic and ground start provisions are made, giving

P2V With Skis Gets JATO Boost

Sixteen JATO bottles boost Navy P2V taking off from U.S Naval Air Station, Quonset Point, R. I, for flight to Antarctic. Aircraft, equipped with skis is attached to Air Development Squadron Six which is supporting Navy's International Geophysical Year activities.

customer a choice of whether he wants a self contained system, combination self-contained and ground cart, or ground cart alone

Whereas Boeing contracted with customers for a certain number of technical representative manhours under its Stratocruiser program, a new philosophy has been initiated in a customer service program for the 707. Under the new philosophy, there will be a Boeing representative at the customer's headquarters as long as the customer flies any Boeing airplanes.

Additional beefup of service has resulted in raising the group to line group under chief engineer, with across the board authority to draw on any talent within Boeing Transport Division required to solve any service problem.

Four main points in new service program are:

- **Open door** to all Boeing facilities for customers.
- **Expedited answers** to all the customer's problems.
- **Interchange of information** between operators.
- **Support programmed** from the customer's viewpoint.

Under the new philosophy, there will be a Boeing man within the Boeing plant who will be designated in effect as a "customer's man" who will bear the responsibility for that customer's airplanes. These customer's men will exchange general operational problem area information, with a view toward upgrading service for all, prevent future problems for those who have not encountered them.

Service Responsibilities

Responsibilities of service department have been broken down into field service, publications, support equipment, training, service analysis and service bulletins.

Field service men (tech reps) are all engineers, many with much practical field experience. They will be trained in all phases of jet transports, not just maintenance, they will have aerodynamics background, be able to derive performance and operational curves.

Program will be flexible, not spelled out as in some cases. Hard and fast rules will be held to an absolute minimum.

Boeing service men will be at the customer's headquarters well before the first airplane arrives, be setting up for arrival of planes and their introduction.

Liaison will be maintained between Boeing and its vendors for customer's best interest.

Publications are being built around new Air Transport Assn. specifications which set standards for manuals, printing, updating procedures, all other aspects.

Support equipment deals with special tools required for 707. Under it will fall responsibility to see that requirements for specialized tools are held to absolute minimum, that tool design will be proven, that tools and equipment required are delivered promptly as needed to the customer. Unit also will set up specifications for test equipment to see that it is compatible with Boeing equipment.

In training, programs are to be set up for the customer's convenience in scheduling his people. Versatile curriculum will be provided, along with experienced instructor staff.

Representative training devices will be used, along with graphic equipment. Functional trainers will be provided for all systems, and if customer does not buy Boeing trainers, Boeing will furnish the customer detail drawings for the customer to build his own.

Service Analysis

Service analysis will work on accumulated and documented experience, will make analysis of service problems, will issue reports and make recommendations and act as Boeing vendor coordinator in this area.

Service analysis group will be independent within service organization, will compile inputs from all customers, will analyze toward a desired fix, and will

Egyptians Display MiG-17s

MiG-17s fly over Cairo, Egypt, during celebration of Egyptian Air Force silver jubilee Dec 19 Soviet-built aircraft flew over Cairo and major towns at scattered intervals No western built aircraft were displayed

spread information on problems to all customers on a preventative basis

Under this setup, while a customer may make one or two inputs, he will be getting outputs from all Boeing airplane operators

In service bulletins, Boeing is trying to standardize on a system of reports which are conducive to mechanization, so that all inputs will be similar for a similar problem area

High Overhaul Periods

Another Boeing effort is toward establishing high overhaul periods for airframe and equipment before the airplane comes out It is hoped that with this Boeing and customers will be able to present a united front to CAA on establishment of these standards

Boeing points out that many items used on the 707 are similar to or identical with those used in piston engine planes, such as fuel pumps These have changed little from DC-3 days through B 52 and KC 135 Boeing believes sufficient experience has been gained in these fields to set realistic standards, rather than consider it a brand new field because it is on a new airplane

Boeing criterion is, "what is safe?" Company feels too much money is tied up in transports to start over from scratch on setting time standards which are difficult to raise once set Jets kept on the ground for replacement of equipment which is functioning perfectly but has run out of a calendar or clock interval, will cost airlines too much money

Company feels that original setting of very high maintenance and overhaul time periods for parts which have been around some years is indicated to start with, will give operators an economic break initially Modifications can be made if records indicate change in time spans

Manufacturing of 707 is conventional, and Boeing has the closely related KC 135 program to draw on for experience in building wet wings (integral tanks), these being company's first production planes with this feature Fuselage construction is similar to C 97

Wing has built up structure skins and stiffeners riveted together Tapered thickness skins are used, with extensive milling accomplished, especially around landing gear In this area common skin extends from wing torsion box back into landing gear trunnion support box structure Largest single skin section measures 100 x 373 in

Since wing has riveted and bolted assembly buildup, new tooling was required Research was done on tape-controlled riveting machines, but in final analysis company chose to stay with hand operations

To accomplish the hand production, Winslow Company of California developed a drill capable of drilling two sheets to required plus or minus 002 hole diameter tolerance without burrs, accomplish drilling and countersinking in one operation

National Aircraft Standards (NAS) Seal Tight Huck and Hi Shear rivets are used Wing is built metal-to-metal, without sealing compound between mating surfaces or around rivets, bolt holes

Wing Assembly

Wings are built up in jigs with trailing edges down due to more extensive work in this area Sequence has spars assembled from milled extrusions which are attached fore and aft, top and bottom to shear web—upper and lower panels fabricated and assembled in—then interspar ribs are installed, after which skins are attached to form wing torsion box

Prior to assembly, skins are anodized with Alodine used on rivet holes and heads after sub-assembly operations Boeing is building a special tank at the Seattle plant where very large skin sections can be anodized in one dipping

Close tolerance forgings are used, with one large chordwise unit located just outboard of outer engines Others are located at wing stubs, wing carry through box in center section and at wing attach points Wings are attached with pins at each spar one pin per spar Rigidity is obtained through the large forgings above and below each spar

A production factor is cast aluminum alloy base and end gates for main wing panel assembly jigs Made of scrap, cast by Boeing, units contain as much aluminum as finished airplane Using alloy takes care of thermal expansion which, on a 100F deg day in Seattle, caused ¼-in elongation

Extensive Honeycomb

Bonded honeycomb, with edges crushed along attach points for continuity and strength, is used extensively in flaps and trailing edge panels, tail group, main cabin floor, tabs and spoilers

Tooling for the crushed edge honeycomb technique is very expensive and tooling qualification is difficult To qualify tools, parts must be fabricated, tested to destruction in necessary modes of failure to prove strength requirements are met Tool then is used to crank out production parts

Much bonding in addition to honeycomb is used throughout the airplane in non-load bearing structure Bonding is accomplished in vacuum autoclaves or vacuum bags

Chemical etch milling is used on leading edge of 707 wing, reducing 080 skin to 040 along spar attach line, yet retaining full thickness at rib attach points

Wing is produced in five major sections center, two main panels, tips

Fuselage construction has two production breaks at which sections are bolted together through mating forgings Assembly is nominally in six longitudinal sections, five major parts and tailcone, with stovepipe joints (skin of one section slides over frame of another, sections are riveted together)

Skin machining is accomplished in fuselage around windows, and at the wing above stub center section

Fuselage Stringers

Fuselage stringers are channel sections, are spotwelded to skins There are three skin pieces per half shell six per circumference Stringer attachment is done with skins still flat, after which completed assembly is wrapped onto fuselage frames and riveted Dogbone ties are used at longitudinal stringer joints

Tear stopper strips 2 to 3 in wide, are wrapped around at each fuselage frame, go over top and bottom of the frame, are spotwelded into place Stringers are offset at these strip locations as required

Belt frames (fuselage frames or formers) are S-section sheet metal Close tolerance forgings are used as window frames. According to Boeing, 44% by weight of the 707 structure was subcontracted

Final Assembly

Airplane final assembly has main wing panels being assembled to center box section, then fuselage sections at wing juncture are installed top and bottom, then remainder of plane Fin attachment is by lugs on each side

In interiors, side panels have been developed of vinyl which is bonded to aluminum alloy The panels are snap-on type, permitting maintenance underneath them quick switch for color scheme changes cleaning

Boeing has developed a standard set of interiors with varying configurations of galley toilet locations lounges seating densities

Interior Fittings

On all airplanes, same set of seat tracks are used which will accommodate either three or two abreast seats Tracks also allow interior flexibility for seating fore and aft adjustment

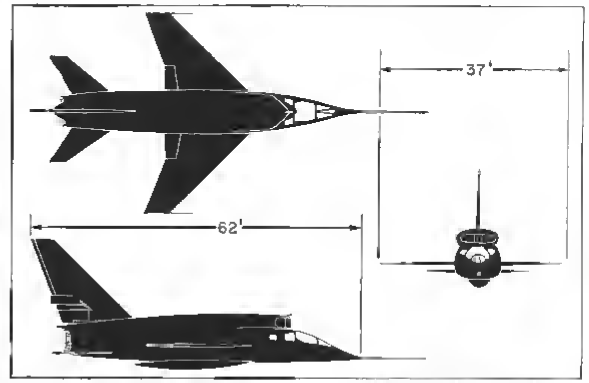
Other interior features are divider panels which can be moved easily to partition off the fuselage into various first and tourist class sections or just to break the monotony of the very long cabin interior

Passenger service pods which contain oxygen masks, lights, signs and other passenger items also will be easily movable Oxygen line will run under hat rack, allow for plug-in at certain intervals

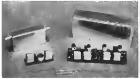
Life raft stowage is overhead, along with other emergency passenger equipment

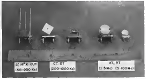
Close up photos of the North American F-107A were made after one of the aircraft had been flown to Wright Field to be placed in Air Museum. Engine air inlet has small boundary layer bleed and fixed geometry center wedge. Mach 2 aircraft is armed with cannon.

F-107A Fuselage Indented to Carry External Stores Pod



Large vertical tail (upper left) is all moving and eliminates rudder. Wedge center post of the engine air inlet is visible in tail pipe view of the engine cavity (lower left). Fuselage is indented (lower right) to take external stores pod shown in three view above.





CRYSTAL FILTERS with four and eight crystals arranged in lattice networks and with inductances added to broaden the passband are shown at left. Typical quartz crystals designed for filter applications appear at the right. Crystal resonant frequencies depend upon dimensions, vibrational mode and orientation of cut

Crystal Filters May Improve Telemetry

By James A Fusca

Boston—Radically improved telemetry, communications and navigation equipments are promised for the near future with the development of crystal filters capable of operating from 10 kc to 40 mc and with bandwidths from one cycle to several hundred kilocycles

These filters make possible a telemetry system that compresses 200 channels of information into the subcarrier frequency range from 16 to 24 kc without commutators Crystal filters also open the way to receivers with a single stage of conversion operating from high through ultra high frequencies for AM, FM or single sideband detection

Theoretical usefulness of quartz crystals as filters has been known for more than 30 years, but commercially available crystal filters have awaited development of practical mathematical tools for calculating their complex physical and electrical parameters and simplified techniques for their manufacture

Solutions to both problems have been obtained by Dr David I Kosowsky who developed the necessary mathematical techniques as a graduate student at the Massachusetts Institute of Technology and, more recently, the production methods as Director of Hycon Eastern's new Crystal Filter Division

Crystal filters consist of two, four or eight crystals arranged in a lattice or bridge network configuration Inductances are placed in series or parallel where widened bandwidths are desired

Advantages in Telemetry

Advantages of a telemetry system using crystal filters can be seen by comparing it with a more conventional system presently in use Features of the system with crystal filters are

- **FM/FM system** that compresses 200 channels, with 5 to 10 cycles of information per channel into the subcarrier frequency range from 16 to 24 kc with separation between channels of at least 50 db
- **No commutators** are required, therefore, failure of one subcarrier channel results only in the loss of one channel of information Furthermore, there is no commutator loss (the finite switching time of a commutator)
- **No second order** distortion products are present because second harmonics of all subcarrier frequencies fall outside the transmitted information spectrum (16 24 kc)
- **Higher frequency** data inputs can be transmitted by translating their frequencies to the subcarrier band or by reducing the number of channels by adding channels with extended bandwidth
- **Small size** of subcarrier oscillators would permit subminiature packaging for airborne use and eventually for missiles
- **Improved stability** due to crystal control of all frequency determining elements

In comparison characteristics of one widely used FM/FM telemetry system produced by a well known manufacturer are

- **Thirteen telemetry channels** are provided internally with provisions for adding three additional channels with external equipment
- **With commutators**, the system in its expanded form can transmit up to 168 channels of information, though with synchronization channels only about 150 can be used for data
- **Frequency range** from 16 to 70 kc is required for 16 telemetry channels, which means that the problem of second order harmonics is always presented

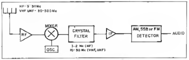
Single Conversion

Designers of avionic equipment for operation at frequencies higher than a few megacycles have resorted to the system of multiple frequency conversion to obtain the required system performance

Multiple conversion, however, increases circuit complexity and frequently contributes additional oscillator noise with a corresponding loss in efficiency and reliability

Use of high frequency crystal filters to obtain a single conversion receiver system offers several advantages (see sketch)

Use of a high frequency first I-F provides excellent image rejection in combination with the high adjacent channel selectivity previously available only with



BLOCK DIAGRAM of single conversion, crystal filter receiver

multiple conversion. At the same time, elimination of multiple conversions reduces cross modulation and receiver desensitization due to mixer overload and locally generated spurious signals.

Because the crystal filter primarily determines the frequency selection characteristics of the receiver, both receiver bandwidth and selectivity characteristics can be altered simply by changing the filter.

Hycon Eastern has designed and produced crystal filters for single conversion receivers with bandwidths ranging from 250 cps for high frequency telegraphy to 50 kc for VHF FM and UHF AM reception. Typical attenuation characteristics for filters used in a conventional single conversion, high frequency receiver are shown in the accompanying sketch.

Doppler Systems

One application of crystal filters just emerging is their use in coherent detection techniques for Doppler radar and fire control systems. Coherent detection involves locating a target return within the limits of the radar's range cycle, defining its position within the cycle and storing the signal over the number of time periods required to build it above the noise level of the detector.

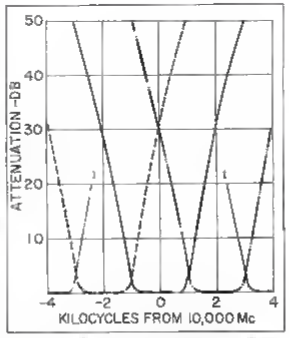
Several characteristics of crystal filters in a modified "comb set" configuration make them useful in the three types of Doppler systems presently receiving attention. These systems are CW (continuous wave) Doppler radars, pulse Doppler radars and pulse reconstruction Doppler radars.

Comb sets are crystal filter units which depend upon the close tolerances that can be maintained on the filter characteristics for frequency channeling purposes. In Doppler applications modified comb sets are used, are comprised of closely spaced, narrow band filters with sharp cutoffs. Part of a bank of this type of filter is shown in the accompanying sketch. Each filter has a bandwidth of 2 kc about a center frequency of 10 mc.

Comb filter sets are presently in use in the simple coherent detection and ranging system developed for the AN/FPS-17 radar by W. M. Siebert of Massachusetts Institute of Technology's Lincoln Laboratory.

A second and more sophisticated system, also using comb sets, is being studied by the laboratory. This system employs a pulsed Doppler radar with a constant repetition rate with comb filter sets to establish a discrete line spectrum for pulse reconstruction and target analysis. This system will be tested initially with the laboratory's new Millstone Hill missile detection radar.

Columbia University's 3,000 mi



MODIFIED "comb set" crystal filter units for use in Doppler radar sets differ from conventional comb sets in that passbands are adjacent, not separated by stopbands.

ORDIR (Omnirange Digital Radar) may use comb sets in a unique way. Some crystal filters, when pulsed, have a transient response that passes through zero. By accumulating a target signal at the filter, then pulsing it and gating the output to a detector when the transient signal is effectively zero, the filter is sampled in what could be called its steady state condition.

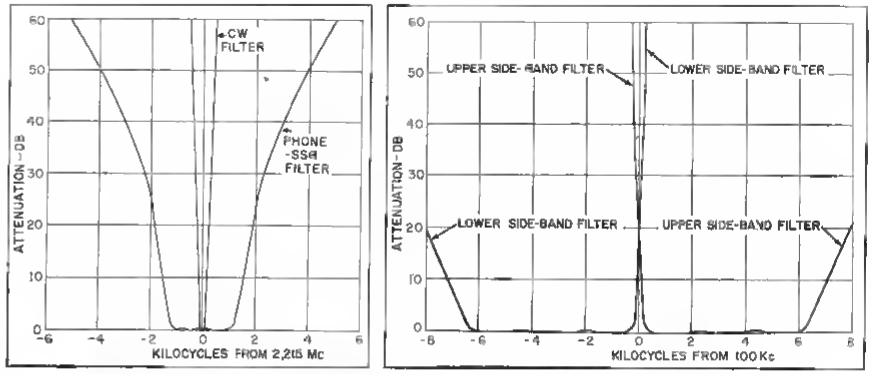
Single Sideband

Crystal filters presently are in use in transmitters and receivers for single sideband operation. In generation of single sideband signals, the signal quality is largely dependent upon the ability of the filter to pass one sideband of an amplitude modulated signal with negligible distortion, and simultaneously to eliminate the other sideband.

Attenuation characteristics for two typical single sideband filters designed to operate at 100 kc are bandwidth of over 6 kc at the 2 db point, with an attenuation slope that goes from 2 to 60 db in less than 600 cycles (see sketch).

Besides their ability to provide asymmetrical characteristics, crystal filters also can simplify single sideband signal generation by reducing the required number of frequency conversions. Conventionally, the generated signal is modulated onto a high frequency carrier through frequency mixing or conversion. As with receivers, one or more conversions can be eliminated by increasing the frequency at which the signal is filtered. To date, crystal filters for this purpose have been produced at frequencies to 16 mc.

For improved single sideband reception, pairs of crystal filters with characteristics similar to those in transmitting equipment can supplement the filter for standard AM phone reception,



ATTENUATION of two filters designed for single conversion HF receivers are at left. Insertion loss is less than 3 db. Attenuation characteristics of two filters for single sideband generation at a frequency of 100 kc. are at right.

limit the receiver passband to the bandwidth of the desired signal.

One of the most severe problems facing the Air Force's Globecom (Global Communications System) is strong adjacent channel interference in the high frequency bands. One method being explored that materially reduces interference caused by intermodulation and desensitization is inserting a crystal filter between the antenna and the first RF stage.

With one or more such filters, any communications receiver can be converted into a fixed channel receiver. At higher frequencies this technique may provide increased selectivity in such applications as ILS, marker beacon and ADF receivers.

Maximum Protection

The maximum possible protection against adjacent channel interference as well as simplicity can be achieved with a tuned radio frequency (TRF) receiver. Not only can the crystal filters be produced below 30 mc to the requisite frequency and bandwidth, but the TRF receiver eliminates circuitry equivalent to the RF, mixer and oscillator stages from the single conversion receiver.

The oldest and probably the best known application of crystal filters is in frequency multiplexing systems, particularly carrier telephone systems. Generally, filters of this type are wide band (4 kc) and spaced about 4 kc. apart in the 60-108 kc range.

Although Hycon Eastern does not expect its crystal filters to compete with Western Electric equipment for telephone system use, there are many other types of carrier equipment manufactured where crystal filters could be extremely useful. One advantage of the crystal filter is that both high frequency and low frequency units can be produced with the same type of attenuation characteristics.

A complete description of Dr. Kosowsky's method for synthesis of crystal filters is contained in his dissertation issued as Technical Report No. 298, Research Laboratory of Electronics, Massachusetts Institute of Technology.

Deriving Equations

In general, the method consists of deriving a general set of equations for a given filter configuration. This set of equations is obtained independent of center frequency, bandwidth and impedance level of the filter. In other words, for each filter network configuration a set of equations can be found that defines the network in terms of ratios which remain constant for that configuration regardless of the values of the filter performance characteristics.

The set of general equations is obtained through two steps, each of which is a normalization or approximation of the rigorous solution. The results, however, are said to be accurate within the tolerances normally placed on filter components. These steps are:

- **Graphical solution.** By breaking the given filter configuration into basic sections (these basic sections generally are mathematical—not physical—entities), solving for the characteristics of these sections and then summing the results, a graphical solution for the filter network is obtained.
- **Algebraic solution.** The graphical solution provides the attenuation characteristics for the given network. From the attenuation characteristics, a network consisting of realizable parameters is synthesized algebraically. These parameters are obtained in the form of a set of general equations defining the network.

Once the equations are derived for a given filter configuration, design of the complete filter is accomplished by simply substituting the values for center frequency, bandwidth and impedance level. Alternatively, the characteristics of an existing crystal can be substituted in place of impedance and the required impedance determined.

Because simple manipulation of these equations provides additional information such as effects of parameter variation on filter transmission characteristics, the normalization procedures are useful not only in filter synthesis but also in determining component tolerances and developing alignment techniques.

The impedance level of a narrow band crystal filter can be varied over a wide range by means of single tuned terminating circuits. Therefore, the same filter may be used at a high impedance level to obtain maximum gain with vacuum tube circuitry, and at lower impedance levels to obtain maximum power transfer with transistor circuitry.

Company Specializing In Microwave Tubes

Watkins-Johnson Co. has been organized at Palo Alto, Calif., for research, development and manufacture of electronic devices, specializing in microwave tubes.

Initially capitalized at $1,100,000, the firm is headed by Dr. Dean A. Watkins, Stanford University professor of electrical engineering, and Dr. H. R. Johnson, recently resigned from Microwave Tube Research Laboratories of Hughes Aircraft Co. Dr. Watkins will

ietam has present connection with Stanford University

Firm plans to locate all its facilities in the Palo Alto area, has a California real estate firm as major capital supplier

FILTER CENTER

▶**New High m Circulation**—Ferrite circulator, capable of handling 60 kw peak power at frequencies of 3.4 8 to 3.5 2 kmc for such applications as a duplexer for airborne mapping radars, has been developed by Cascade Research, Los Gatos, Calif. Device will handle 25 w average power, with 20 db isolation, less than 0.5 db insertion loss, and reportedly has VSWR of less than 1.25 over band. Circulator weighs 11 oz.

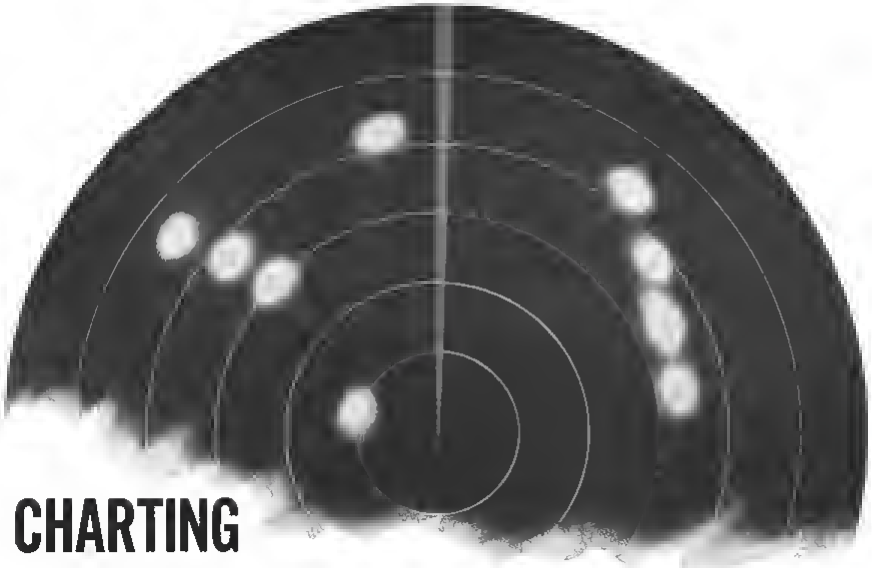
▶**WCEMA Aids Future Engineers**—San Francisco Council of West Coast Electronic Manufacturers Assn. makes available to area high schools surplus electronic materials and components for classroom or laboratory use as part of an active program to interest more students in engineering. Program also includes providing qualified speakers and plant tours.

▶**New Transistors Down Under**—New alloyed junction PNP transistor for high current switching applications with switch-on time as low as 0.5 microsecond is one of several semiconductors developed by Australia's Commonwealth Scientific and Industrial Research Organization in Sydney.

▶**More Transistor Price Cuts**—Philco Corp. has cut prices on many of its transistors, including some surface barrier types, by as much as 35%. Other types include medium and high power alloy junction. Cuts are attributed to automatic production facilities now in use at Philco's Spring City, Pa., plant.

▶**French Accent on Lear**—Lear's L-102 transistorized autopilot is now specified as standard equipment on the French Sud Aviation's Caravelle twin jet transport, company says. Lear reports $1.5 million in L-102 orders for Caravelle.

▶**PAA, NAA Buy Radar**—Pan American Airways and North American Aviation have placed sizable orders for General Precision Laboratory's Radan—an 89 lb. Doppler radar auto navigator. PanAm has ordered Radan for its entire fleet of 44 jetliners following initial tests aboard a DC-7C which has made 18 transatlantic crossings to date. North American contract, for undisclosed use, totals over $1 million and is largest yet for Radan systems.



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SERVO FLAPS are visible on main rotor blades on mockup General Electric T58 gas turbine engine is mounted high in fuselage.

Navy Orders Four HU2K-1 Prototypes

Kaman Aircraft Corp has been awarded a $13 million U S Navy contract for four prototypes of the HU2K 1 utility helicopter Powered by a General Electric T58 gas turbine engine, the new aircraft is the first single rotor design built by Kaman

Pictured is a mockup of the craft showing retractible landing gear and four-bladed rotor with 'servo flap' control system

Servo flap mounted on each rotor acts as an aerodynamic servo which is said to provide simplicity of construction ease of control and inherent stability to the rotor blades Excellent pilot visibility also is indicated by the mock up

Navy Bureau of Aeronautics selected HU2K-1 design in a competition for a utility helicopter (AW Jan 28, 1957, p 23) Other helicopters competing were Vertol HUP-4, and designs by Bell and Hiller

FULL SIZE MOCKUP of Kaman HU2K 1 utility helicopter shows how landing gear will retract forward into well in side of fuselage.

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THREE FRENCH Army Vertol H-21s wait for troops to load at a pickup point in Algeria. White lettering on ground guides pilots

Special Report From Algeria: Part III

French Army Greases Spares Pipeline

By Robert E. Farrell

Setif, Algeria—One of the western world's most active military helicopter bases is being operated here by the French Army against Algerian nationalist bands.

Setif is located at an altitude of 3,000 ft. atop a fertile plateau region in eastern Algeria. To the north lie the Atlas mountains and just south of Setif stretch the rugged Aures mountain chain where the rebellion began three years ago. It is in and around these mountain territories that Setif Army helicopters carry out the majority of their missions. Of the missions, the most important are commando assault operations using Vertol H-21s.

Helicopter Increase

Army began its Setif operation just over two years ago with three Bells and two Sikorsky S-55s. Today, the Setif base is operating a fleet of 122 helicopters which includes six different helicopter types. All are used either directly in combat against the rebels or on support missions such as supplying Army outposts.

French Army helicopters theoretically are responsible only for combat missions in eastern Algeria, a territory as large as the U. S. east of the Mississippi, though some Army aircraft occasionally cross over to support operations in the Air Force sector in western Algeria.

Setif is so located that all Army garrisons in eastern Algeria are within 2½ helicopter flight hours. This means the longest delay between the sighting of a rebel band in one of the mountain areas and the actual combat is theoretically just under three hours. The extra time is taken up by the rotation from 10 minutes to a half hour, between an Army garrison and the fighting area. In practice, however, the Army often moves at a quicker pace since H-21 troop-carrying helicopters usually are stationed throughout the Army sector, returning to Setif only for maintenance. Then too, many of Army's helicopter missions these days are more of a planned nature where surprise attacks are staged against areas where rebel bands are thought to be dug in.

Present Army equipment being flown at Setif is as follows:

- **Thirty-three** Bell 47G-2s, mostly built by the Milanese firm of Agusta.
- **Nineteen** Sud-Aviation Alouettes.
- **Twenty** Westland-Sikorsky S-55 Whirlwinds, built under Sikorsky license and powered by a 600 hp. Pratt & Whitney 1340 engine.
- **Six** Sikorsky S-55s powered also by the P&W 1340.
- **Five** Sikorsky type H-19D3, powered by 800 hp. Wright R1300-3 engine.
- **Thirty-nine** Vertol H-21 "Work Horses."

LEFT main gear in air, French Navy Vertol H-21 discharges commandos during combat.

Until recent weeks, French Navy also operated eight H-21s at Setif under Army directions. The Navy force now has shifted over to Sidi-bel-Abbes in western Algeria where it will continue to operate combat missions at Army request. The Sidi-bel-Abbes base actually is Army's central helicopter training operation. Fourteen WS-55s and seven H-21s are stationed there for training purposes. It is also at Sidi-bel-Abbes that Army is combat operating its seventh type of helicopter, the Sud-Aviation Djinn turbine helicopter.

Army's Setif operation has changed considerably since AVIATION WEEK's first visit a year ago, when about 50 helicopters including the first batch of seven H-21s were on the base. Today, the physical set-up has much improved. This is evidenced by hard-topped landing areas, an abundance of ground handling equipment and even huge hot-air heaters in the hangars.

As a year ago, it still is obvious that Army is spending more money on its helicopter operation than is Air Force. Also, Army maintenance methods and capability have considerably improved over the year and now appear to equal those of Air Force. Moreover, Army is doing a better job than Air Force in keeping its spare parts pipeline flowing smoothly. This is perhaps explained by the constant and close relationship between Army and its heavy helicopter supplier, Vertol Corp.

While Setif can rightfully claim six different helicopter types, Army officers indicate they would be better off with just two: the five-place turbine Alouette and the troop-carrying H-21. These two helicopters, Army feels, would cover its requirements.

The Alouettes first came to Setif last May, several months after the Air Force began operating them out of Boufarik in western Algeria. Present number of 19 is only the first batch of a much larger order placed by Army with Sud Aviation. Mission work of Army Alouettes divides about equally between liaison, evacuating wounded, for which Alouette is specially suited, and, finally, as a flying command post.

Setif Alouettes are averaging about 50 flight hours monthly. Like the Air Force, Army has been pulling turbines at 250 hours although this red line mark is now being advanced to 500 hours. Army claims an availability rate of 80% on its Alouettes. This is 20% higher than Air Force experience at Boufarik with the Alouette. Alouette maintenance, Setif engineering officers say, is even easier than the Bell.

Main interest at Setif centers on the exploitation of the Vertol H-21, which the French, ignoring the craft's official nickname of "Work Horse," insist on calling the "Flying Banana." The first H-21s went into operation in June, 1956. Since then a dozen have passed the 300 hour inspection mark while the oldest Setif H-21 had logged 646 hours by the end of November. By that date, Setif H-21s had transported about 70,000 commandos and had racked up 10,000 combat flying hours.

Of the 39 H-21s now at Setif, 15 have some of the latest modifications which include wheel gear fairings and a slightly higher engine output resulting from the installation of a low velocity engine cooling fan. In addition, several minor modifications have been made by the French at Setif.

For example, French Navy developed a cable system, used now by Army as well, which permits the main cabin door to be yanked shut from the pilot's compartment. On short troop rotation flights only pilots remain after evacuation and it was discovered that loose equipment was being sucked out of the craft's main cabin door into the rotor blades.

Another trick used by some H-21 pilots at Setif is to fix an ordinary truck rear view mirror onto the nose support structure so that unusually rough terrain under the main gear can be

FRENCH Army Vertol H-21 comes in (above) to pick up commandos in early morning. Below, Army H-21s take off loaded with commandos for short flight to combat area

FRENCH ARMY Westland WS 55 approaches outpost in Algeria to deliver supplies.

FRENCH NAVY Sikorsky H 19s from the Navy base at Lanlique are shown on patrol

spotted during combat mountain landings

On a normal flight these mirrors are turned to prevent drag

One of the most satisfying aspects of their H-21 experience, French say, is the surprising amount of punishment the craft has taken from rebel small arms fire without being knocked down. Army has lost only four Vertols as a result of ground fire In one case the helicopter crashed after both pilot and copilot were killed at the same time. Sctif records show time and time again that the H-21 kept flying after being hit in critical areas The following random examples of combat damage are taken from official records

Drive Shaft Hit

Last September an Army H-21 with 131 hours was hit several times by ground fire while making an approach to disembark troops One bullet in the 30 caliber class passed through number two drive shaft, split into three parts and exited. Result was a hole of approximately 1 in in the drive shaft Pilot reported no unusual vibration and continued to fly the mission which lasted another 30 min

Another drive shaft incident took place in the same month on a commando-assault mission This time the bullet passed cleanly through the drive shaft leaving a considerable hole Helicopter flew another hour before damage was noticed

Last July, a rebel bullet in the 30 caliber class struck an H-21 transmission case at a 45 deg angle The case cracked one quarter inch at impact but the helicopter continued to fly for six hours without any leakage

In August, an H-21 coming out of the combat area received a bullet

through the diverter segregator valve. Pilot later reported he was unaware that any vital part of the craft had been struck since all flight instruments continued to give normal readings. Damage was discovered only after shutdown when oil splashes were discovered on tail.

Makeshift Repair

Recently in the Setif area an Army H-21 had its longitudinal cyclic cable severed by ground fire. The H-21 landed outside the combat area and the crew chief used a piece of wire to join together the two severed cable ends. The H-21 then took off and flew 1 hr. and 45 min. back to Setif.

Pilot reported flight handling was nearly normal, but with some slack in the controls.

The way in which the H-21 has held up under combat fire has caused Army officials to drop earlier plans to place armor around engine and rotor head regions. Army has insisted on self-sealing fuel tanks and at present about half the H-21s at Setif are thus equipped.

Maintenance of the H-21 has given them little trouble, Army officers say. Like French Air Force experience with the Sikorsky H-34, Army's main headache is also with the Wright 1820 engine. Average engine life at Setif is down to 250 hr. with some engines being pulled as early as 150 hr. Partial reason for this, Army admits, is continual strain placed on engine during combat missions when pilots overspeed the engines either by mistake or necessity. French complain that the overspeed margin on the Wright engine is too narrow. Engine has a rated rpm of 2,700 and requires inspection if oversped to 2,780. This margin is too delicate to be practical during combat operations, French argue. They would like to see a margin of at least 200 rpm.

Biggest engine trouble at Setif on the H-21 has now been licked. This concerned engine skips when the engine would cut out for a split second, then resume operation after a loud backfire. French and Vertol representatives at Setif claim the trouble stems from faulty valve operations though there seems to be some disagreement on the point. At any rate, the phenomenon all but disappeared following valve guide reaming changes and the restoration of scrapers in the valve guides.

One final engine problem is high oil consumption. Air Force has same problem with the Wright in the H-34. Very likely the reason for this is the large amounts of sand which are encountered during missions. At times handfuls of sand can be scooped out of the induction system.

Capt. Louis de Lest, Setif engineering officer, says H-21 availability often

goes is high as 80% and rarely falls below 70%. During the first six months of H-21 operation in 1956, when the Vertol craft first came to Algeria, availability averaged 58.5%. Official records show that maintenance hours per flight hour is around six, which is lower than U.S. military average. However, a certain amount of over-maintenance is done at Setif partly for training purposes, so that the actual maintenance hours per flight hour is around 10.

Maintenance work at Army Group Helicopter Two is done through third echelon level and often goes through fourth as well. Most of the Army mechanics are now well trained and can work through a 450 hr. inspection within 12 days. French mechanics are helped by a team of Vertol field representatives who live at Setif.

French Army officers express complete satisfaction with the support they are getting from Vertol, particularly on the matter of spare parts. Capt. de Lest says it is rare when a H-21 is on the ground because of a spare parts problem.

This is not the case with most other manufacturers, he says. Army has an agreement with Vertol under which emergency spare parts are airlifted directly to Algeria from the U.S.

Necessity of spare parts airlift is infrequent, Vertol reports. Small components not available in Algeria, however, are airfreighted commercially upon receipt of cable in accordance with spare parts contract with French government.

Availability Records

Availability on Setif's 33 Bell 47Gs is about 75% and, except for occasional malfunctioning of servo controls, these light helicopters give Army little trouble. This isn't so much the case with Setif's 11 Sikorsky S-55s (both Pratt & Whitney and Wright engines). Availability on these craft has dropped to 60%, mainly because of difficulty in getting spare parts.

Army is still dissatisfied with performance of the Westland Whirlwind S-55 which is powered by Pratt & Whitney 600 hp. engine. Most of the P & W engines used in the Setif Westlands are overhauled jobs with one dating back to 1944. Trouble with the WS-55 is the same as with the Sikorsky S-55 P & W model: not enough engine.

Westland hopes to overcome this deficiency by talking Army into buying the WS-55 with an Alvis Leonides Major 850 hp. engine.

Army gets about 80 hr. weekly out of the 20 WS-55s at Setif. Availability during 1957 was often below 50%.

Army, incidentally, now and then installs Sikorsky S-55 main and tail rotor blades as well as the S-55 clutch unit on the Westland WS-55. This parts

snatching doesn't seem to work the other way around.

While Army Djinn helicopters presently are operated out of Sidi-bel-Abbes rather than out of Setif, it is likely that the two-place jet helicopter will someday move into the Setif operation. The 10 Djinns now in western Algeria are being used mainly on liaison work. The Djinn will stay in the air for 1 hr. and 45 min. and cruise at 60 mph.

Top speed is 80 mph. The Turbomeca Palouste engine is being pulled at 300 hr. Army hopes to have one Djinn for each combat battalion. Quick takeoff time, about two minutes, plus fact Djinn can even operate on truck fuel, are factors which particularly appeal to Army pilots.

Vibrating Slosh Table Tests B-52G's Tanks

New slosh table designed by Boeing will test B-52G wing tanks for resistance to the combined effects of vibration and liquid slosh. Vibration is created by means of four power-driven wheels, each with a hollow pie-shaped wedge that can be filled with water. Mounted near the corners of the table, the wheels induce a vibration rate which can be varied by adding to or reducing their water amount. While vibrating, the table rocks on an axis to create the slosh effect.

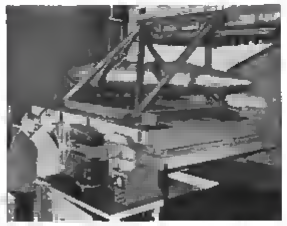


TABLE tests B-52G wing tank for resistance to vibration and slosh effects.

The table is constructed in two levels, the lower providing the sloshing action while the upper section with the water wheels induces vibration. Structural weight is 43,000 lb., it is mounted on a 315,000 lb. reinforced concrete base.

Capacity is 37,500 lb., slosh and vibration. 50,000 lb. slosh testing alone. Vibration can be varied up to 2,000 cps. Test models are mounted on the table in special jigs which can be adjusted to simulate flight attitudes.

In use at Boeing's Wichita Division, the table's chief advantage is said to be its ability to reach desired vibration levels without the danger of passing through its resonant frequency.

Nose Cone Forming

Nose cones for the Air Force's Atlas and Thor ballistic missiles are being formed by Lukens Steel Co. on a four-post hydraulic press capable of exerting a force of up to 4 million lb. Material for the nose cones is the same for both the intercontinental Atlas and the intermediate range Thor. Prime contractor for both the Atlas and Thor programs is General Electric Co.

MULTI-JET noise suppressor is attached to P&W J75 15,000 lb thrust gas turbine on test stand at Republic Aviation Corp., Farmingdale, N. Y. Silencing unit weighs 400 lb.

Silencer on J75 Drops Noise Level 35 Decibels 250 Ft. From Tailpipe

Jet engine exhaust noise suppressor which is light enough to hang on the tailpipe of a gas turbine engine with quick-adjusting clamps is gaining industry acceptance.

Called "Multi-Jet," the silencer recently completed successful evaluation tests at Republic Aviation Corp.'s Farmingdale, N. Y. plant where it was used with the Pratt & Whitney Aircraft J75 15,000 lb. thrust engine which powers Republic's supersonic F-105B.

Some months ago, a smaller version of the suppressor was hung on the tailpipe of a General Electric J57 on a B-47 in the number one position. Recently, the suppressor has been tested on other positions. Also, additional B-47s have been equipped with the suppressor to silence static ground run-up operations.

Boeing 707 Test

New version of the silencer will soon be supplied to Boeing for test with its 707 production jetliner, according to the manufacturer, International Aerocoustics Corp. Because of the interference of the 707's airborne noise suppressor, the ground unit will not be designed to hang on the tailpipe.

Instead, it will be mounted on a mobile cart so it can be rolled into position. Provisions will be made to raise and lower the device to accommodate inboard and outboard engine heights.

Company says that it is also in contact with Douglas for its DC-8 and with Convair for its 880 commercial jet transport.

Sound Attenuation

International Aerocoustics' President, Martin Hirschorn, told AVIATION WEEK that the Multi-Jet suppressor could give these attenuations at the distances noted:

- **J75**: at a distance of 250 ft. from the tailpipe and 45 deg. from exhaust, noise level reduction from 125 db. to 90 db.
- **J57**: at a distance of 150 ft. from the tailpipe and 45 deg. from the exhaust, noise level reduction from 130 db. to 100 db.

Big advantage of the units, company says, is their lightness. The five-cone suppressor used by Republic on the J75 weighs 400 lb. The smaller suppressor used on the B-47s weighs but 180 lb. It can be installed by two men in less than five minutes. Cost is approximately $6,000.

Maker feels that the silencer will be valuable to both commercial airlines and the military as a lightweight mobile device to quiet engine run-up operations at airports and military fields where noise suppression is desirable.

Made Under License

Company is making the Multi-Jet under license from United Aircraft Corp. A year and a half ago, Pratt & Whitney offered the same unit (except that it had only three cones because it was used with a J57 engine) without charge to the industry and the military (AW May 28, 1956, p. 91).

International Aerocoustics Corp. is a new company which formerly was Aviation Division, Industrial Acoustics Co.

In addition to the Multi-Jet, firm also will market "Acou-Stack" and "Dura-Stack" jet engine and turboprop noise suppressors. Address: 241 Jackson Ave., New York 54, N. Y.

Pod Toil Lights

Latest modification to B-58 pods currently being test-dropped at Holloman AFB's missile test range are these twin, high intensity tail lights. One flashes at instant of impact, the second 1/1,000 of a second later, allowing high speed cameras to record the split second of impact. Purpose of the tests is to gather information through telemetered data, on such variables as pressure, temperature, vibration, acceleration, displacement, position, noise and strain occurring on and in the pod from the time it is released to the time it destroys itself upon impact. All test pods are specially instrumented for the drops. In a typical drop test, a B-58 takes off from Convair's Ft. Worth plant, drops a pod on Holloman's missile range, then lands at near-by Kirtland AFB to pick up another pod for test. Under actual operational conditions, equipment pods would contain nuclear bombs, reconnaissance cameras or electronic countermeasures.

Titanium Investigated For Supersonic Uses

An 18-month study program will be started early this year by Convair San Diego to investigate the use of newer titanium alloys in future supersonic aircraft and missiles.

Company was awarded a development study contract in excess of $1 million by the Air Force.

Prime purpose of the study, which comes under a broad Department of Defense development program, is to determine the adaptability of the new alloys to the design, fabrication and construction of future weapon systems.

Titanium was selected because of its heat resistance and the weight advantages it offers to airframe construction in the temperature range of 350F-800F.

Convair's titanium study will be divided into these five major phases:

- **Choice of parts** which, if fabricated from titanium alloy, will offer greatest benefits to the Air Force.
- **Selection** of three most promising alloys produced by titanium manufacturers. These will be subjected to series of nine detailed test programs.
- **Development** of advanced production fabricating techniques.
- **Fabrication** of parts chosen under first phase from alloys selected under second phase.
- **Testing** titanium parts to loadings similar to those expected to be encountered in supersonic aircraft and missiles.

Convair says objectives of this study will be to develop manufacturing methods and processes, fabricating and tooling techniques consistent with engineering designs by which components can be manufactured in production quantities from titanium alloys in support of a normal aircraft or missile schedule.

Aileron Gap Strip Kit Designed to Aid DC-3

Stalling speed reduction of 7 to 8 mph. on DC-3s can be achieved by installing aileron gap strips to narrow the gap between upper surface of wing trailing edge and aileron leading edge, according to flight tests recently performed by AiResearch Aviation Service Division, the Garrett Corp.

Corollary advantages include shorter takeoffs and landings, increased rate and angle of climb, improved single-engine performance and retardation of the "so-called uncontrollable roll" because aileron control is effective with the plane in a stalled condition, says the company.

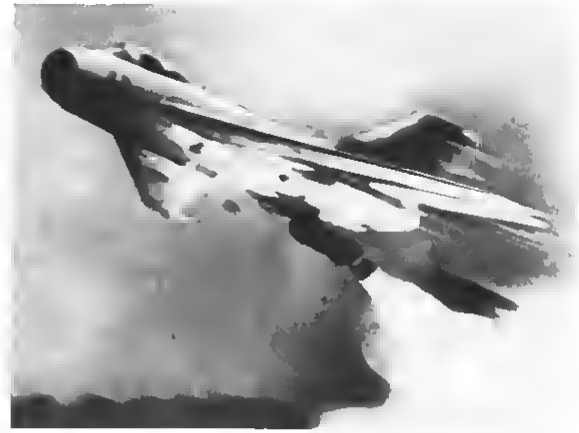
Kit consists of specially-designed aluminum strips attached to the trailing edge of the plane's wings which close the existing large upper gap to about the same dimension as the smaller gap on the under side of the wing.

AiResearch's Aileron Gap Strip Kit has been approved by the Civil Aeronautics Administration for all DC-3 weights up to and including 26,900 lb.

OFF THE LINE

Specially-developed package for shipping 48 ft. 8 in. long, 70 lb. wing spar caps for Convair's 880 jetliner cuts costs of conventional boxing methods 75% and weighs only 140 lb. tare. The package is sufficiently rigid to resist torque and is light enough to be handled by four men. Concept is Convair's, and package was manufactured by Flexline Products, Los Angeles, of Celotex.

Seals made from converting Kel-F resins into parts which remain flexible at the —300F temperatures of liquid oxygen are being made in production quantities by Lindsey Plastics Corp. Company says the seals are being used in liquid oxygen engines and converters over a wide pressure range. Other products include plastic sheet, rods and tubes.



Red Rocket-Boost Pilot Uses U.S.-Type Helmet

Soviet fighter is boosted into the air from a mobile launcher by an under-belly rocket of undisclosed thrust. Russians claim this system enables fighters to take to the air from fields, forests or mountains. Concept is reminiscent of zero launcher tests conducted in 1954 and 1955 by USAF with F-80 and F-84 fighters.

Soviet test pilot Col. V. G. Ivanov (left) flies fighters from launchers. Note striking similarity of his helmet to standard USAF P-4 head gear worn by U.S. pilot (right).

First Temco TT-1 Trainers Come Off Production Line

First four production models of Temco TT-1 Navy trainer are now undergoing flight tests. Detailed photos show changes in gear design from prototype (AW Dec. 30, p. 67). Note inboard main and nose gear doors closed, outboard doors opened with gear extended. Temco is moving its TT-1 flight test program from Hensley Field in the congested Dallas area to Majors Field, Greenville, Tex., 50 mi. northeast of Dallas. Final delivery on the 14 TT-1s ordered by the Navy is scheduled for mid-1958.

MODEL of the S-62 shows turbine engine located above the cabin, flying boat type hull and sponsons for water stability. S-62 uses complete S-55 dynamic system but has 700 lb. greater payload, primarily because of the lightweight gas turbine engine.

S-62 Sales Timing Tied to Turbines

By J. S. Butz, Jr.

Stratford, Conn.—Sikorsky Aircraft is combining two sought after helicopter characteristics — turbine power and proven, long life components—into a privately financed, amphibious machine timed to reach the civil market just as the cost of turbine engines reaches a commercially acceptable figure.

The dollar per horsepower cost of the new light turbine engines, by Sikorsky's estimate should be down to piston engine level by late 1959. The company's new helicopter, the S-62 (AW Dec. 30, 1957, p. 25), is scheduled to meet this date by completing its test program in fall 1958 with deliveries planned 12 months later. First flight is set for May this year.

Accuracy of the Sikorsky turbine development time estimate depends on a number of factors. Most important of these are:

- **Number of orders** placed with General Electric and Lycoming for their T58 and T53, respectively, which can be installed in the S-62 and most of the first generation of U.S. turbine powered helicopters.
- **No stretchout** or reduction in military support for the engine program.

Potentially Competitive

If the time estimate is correct and gas turbines are economical within two years, the S-62 will place Sikorsky in a formidable competitive position in the civil market. Along with realizing the weight benefits of the turbine engine the S-62 uses the complete dynamic system from the S-55. This system has been in use for almost nine years and its separate parts: rotor blades, rotor heads, gear boxes, shafting, etc., average almost 1,000 hr. between overhauls.

In contrast, a completely new dynamic system initially would be allowed in the neighborhood of 200-300 hr. service life, and parts replacement cost would be multiplied about four times. Parts costs are the major expenditure in operating helicopters so the S-62 will enter service in this respect in the favorable position of a machine with nine years and over a million flight hours to its credit.

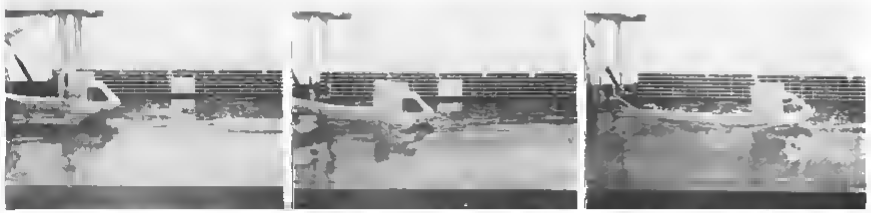
Another benefit is that helicopter operators with S-55 parts will be able to use them on the S-62. The S-55 parts are in volume production and therefore are priced lower than new parts.

Substantial savings also are expected on S-62 development costs. Dynamic system design normally accounts for about 75% of helicopter design time and expenditure. The fly-away cost of the S-62 could then be well below the usual for a medium-sized helicopter.

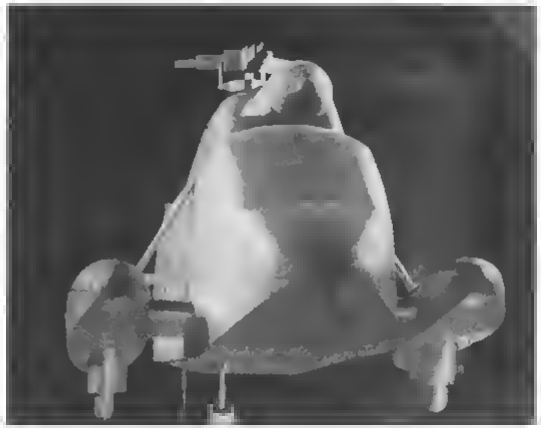
Development Time

Development time on the S-62 will be about two years from inception last September to flying production models, this time could be shortened several months depending on the amount of additional effort and money used, according to Sikorsky officials. Ordinary development time for a completely new helicopter of this size is three to five years.

Direct operating cost for the S-62 will be close to the S-55 if specific fuel consumption of the turbine engines reaches the desired figure. Consumption will be higher on the S-62 but the fuel cost lower. On a ton-mile basis



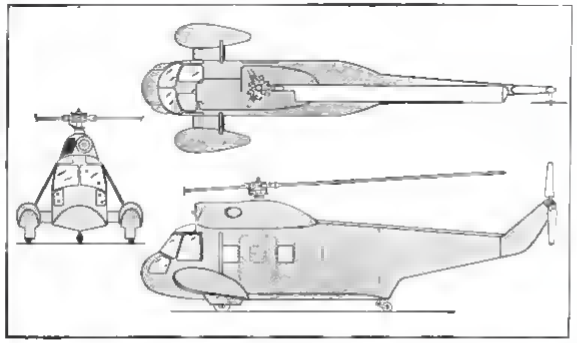
SEQUENCE shows model dynamically similar to S-62 during simulated autorotative water landing. Tests showed such landings . . .



SIKORSKY S-62 wind tunnel model is shown above during test program conducted in a United Aircraft Research Department tunnel.

S-55 floats (above) weighed 400 lb.; water capability of new S-62 cost only 100 lb.

COULD not be made safely with usual round bottom, round nose fuselage shape, so flying boat type hull was incorporated in design.



S-62's S-55 dynamic system has seen service almost 9 yr.; overhaul life averages 1,000 hr.

WATERTIGHT hull makes the S-62 amphibious, yet adds only about 100 lb. to the empty weight

the S-62 will have a decided advantage because of its 700 lb greater payload, about a 30% improvement over the S-55.

Off the Shelf

Regardless of the accuracy of the turbine development time estimate Sikorsky General Manager Lee S. Johnson has considerable hope that the S-62 will be interesting to the military as an off-the-shelf utility helicopter. Military need for payload capacity and performance being greater than the cost requirement makes turbine powered helicopters attractive to the services even if the new engines don't reach piston engine prices. For instance, the S-62 with 30% more payload than the S-55 carries no more power in the transplanted dynamic system but it has 230 more horsepower available and can maintain full power in hotter weather and at higher altitude. The S-62 therefore would be available in many more situations than its piston-engined counterpart.

Current market situation for a military utility helicopter is that the older piston engined models have been or are being phased out of production. The new turbine powered aircraft being developed as replacements are in most instances three to four years away from production deliveries. Sikorsky with additional effort, could roll out the first production S-62 in about 18 months and provide the services with an interim machine at a substantial savings in operating and initial costs.

Principal fuselage difference between the S-62 and the S-55 is a watertight hull on the new machine allowing water takeoffs and landings. This is a performance boon for civil and military operators as the heavier hull and sponsons on the S-62 add only an estimated 100 lb to the empty weight. In comparison, float gear for the S-55 adds about 400 lb. Drag differences between the floats and sponsons amounts to 10-15 kt. at cruise power.

Watertight Bottom

The flying boat hull on the S-62 took some Sikorsky engineers back to their flying boat days. The watertight bottom had to have a definite chine and step to obtain the required water handling characteristics. A simple round bottom, round nose hull develops downward lift as it moves through the water. During an autorotative landing when the forward speed grows large, the nega-

tive hull lift can almost suck the aircraft under.

This effect was countered with the usual flying boat hull. A special tank was built and several models tested to obtain the optimum configuration.

The hull is stressed to operate off the water continuously as would be necessary during training for emergency water landings.

Structurally the hull is of conventional aluminum construction. It has several watertight compartments and if any one of these compartments is flooded due to damage the aircraft is designed to stay afloat and operable. The sponsons also are compartmented and may sustain damage without losing effectiveness.

The watertight compartments in the hull bottom are used as fuel tanks. The V shape of the bottom simplifies the fuel pumping system and is less elaborate than on a helicopter which has flat bottom fuel tanks.

The S 55 dynamic system used in the S 62 requires only one additional component to adapt it to the free turbine powerplant which has substantially different operating characteristics than the piston engine.

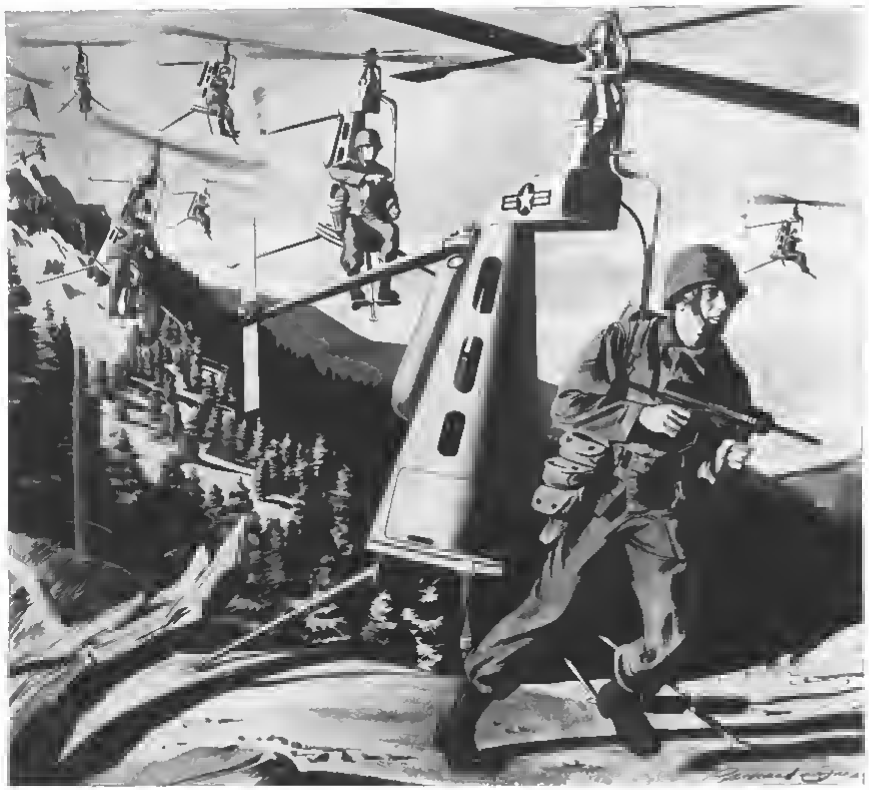
An extra gear box is used to adjust power output so it may be transmitted by the S 55 gearing.

PRIVATE LINES

Development of low cost single and two place commercial helicopters and studies of similar vehicles for military will be undertaken by newly formed DeTemple Helicopters Inc., Los Angeles, Calif. Chairman of firm is Don B. DeTemple.

Ross Aviation, Inc., Tulsa, Okla., will be new fixed base operator at North Philadelphia Airport. Highest bidder of three firms participating, Ross succeeds LaHava Air Service, whose contract expired. Firm will pay the city 5% of gross revenues from fuel and lubricant sales, a minimum of $1,000 monthly rental and 5 1/2% of revenue from aircraft servicing and miscellaneous sales. Operator will operate in a new hangar that will be opened in mid 1958.

Investigation of recent Cessna 172 crash where pilot overshot Pendleton Airport, Ore., by 65 mi. to crash into a hill during a short flight revealed that he was diabetic and subject to insulin reaction. Pilot had withheld condition from examining doctor and was issued a Class II physical certificate only a few days prior to the accident. Cause of the accident was assumed to be an insulin reaction followed by loss of consciousness.



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MAXIMUM AERIAL MOBILITY is an important aim of America's military forces. Solar advanced technology is helping to realize this goal by designing the smallest gas turbine aircraft engine ever built. The 55 hp Titan engine, weighing only 50 pounds, will power one-man helicopters like those pictured in this artist's conception, as well as flying platforms. It represents an important addition to Solar's growing family of gas turbine engines.

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WHO'S WHERE

(Continued from page 23)

atrol Division, Servomechanisms, Inc., Hawthorne, Calif.

Al Grand, flight instructor in charge of the Chicago training facility, Flight Safety, Inc., Flushing, N. Y.

Joseph M. Martin, Sr., manager design department, and **Paul L. Ashway**, manager fabrication services, Datalab division of Consolidated Electrodynamics Corp., Pasadena, Calif.

Frank J. Cummuskey, manager Marketing Division, Owego Military Products Division, International Business Machines Corp., Owego, N. Y.

Richey W. Whitesell, manager-airframe products section, and **Rudolph Bodemuller**, manager systems development section, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.

William G. Orr, director-support services programming, The Garrett Corp., Los Angeles, Calif.

Solar Aircraft Co., San Diego, Calif., has announced the following additions to the staff of the missile engineering group of the Research and Development Engineering Division: **Karl F. Greil**, head preliminary design, Dr. **Frederick W. Ross**, chief of aerodynamics, **Laurence H. Cherry**, chief of research and development planning, **Morris Kaswen**, chief of guidance and control, **M. C. Towns, Jr.**, chief of propulsion, **Daniel H. Driscoll, Jr.**, senior propulsion engineer.

Robert E. Forney, assistant to the director of service engineering, Minneapolis-Honeywell Regulator Co.'s inertial guidance plant, St. Petersburg, Fla.

R. J. Wright, manager Washington, D. C., office, The Garrett Corp., Los Angeles, Calif. Mr. Wright succeeds **Myron A. Tracy**, now manager military contracts and support programs, Garrett's Military Relations Dept., Washington, D. C.

Robert D. Walker, product engineer Silicone Rubber Operation, Plastics Department, General Electric Co., Decatur, Ill.

Charles S. Wiggins, manager Washington, D. C. office, Borg-Warner Corp., Chicago, Ill.

Dr. Wayne H. Jens, assistant technical director, Atomic Power Development Associates, Inc., Detroit, Mich.

James F. Buckley, director of sales and service, Eclipse Pioneer, division of Bendix Aviation Corp., Teterboro, N. J.

Walter G. Sittmann, head newly established Upper New York State Division (Rochester, N. Y.), Oakite Products, Inc., New York, N. Y. **John F. Melhado** succeeds Mr. Sittmann as Pittsburgh division manager. Also **Victor L. Baltzell**, manager newly established Mid-South Division (Louisville, Ky.).

Stanley N. Gulick, Greater New York area manager, Northeast Airlines, Inc.

Irwin Zelman, manager laboratory facilities, Hastings Plastics, Inc., Santa Monica, Calif.

Dr. George Manov, technical director, Reactor Monitoring Center, Tracerlab, Inc., Waltham, Mass.

Arthur C. Omberg, general manager-missiles section, Products Division, Bendix Aviation Corp., Mishawaka, Ind.

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Airline Captain 33, C-46 rated 3800 hrs experienced international domestic DC 6 DC-4, DC 3, light aircraft, available immediately will travel PW-7050, Aviation Week.

Pilot-salesman desires corporation position 4000 hours (jet and conventional). College grad married age 37 good flying and sales background. PW-7071 Aviation Week

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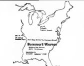

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AVIATION WEEK, JANUARY 20, 1958

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LETTERS

Gamma Photons

Although agreeing in principle with the observations of A Machado, Jr (AW Nov 25, p 126), we feel that basically more attention should be paid to his assumption concerning gamma photons

Close to the nuclei of heavier elements ($A > 200$) where the transformation $\gamma = {}_{-1}e^0 + {}_{+1}e^0$ would be effective, the conversion factor 12_0 would produce a different effect on any isotopes (particularly ${}_{92}U^{235} + {}_{1}e^0 = {}_{91}Pa^{235}$) as outlined recently (November 1956) by A N Nesmayanov in his paper delivered at Leningrad University Nesmayanov's paper was based on the little known expression for gamma photons when subjected to temperature variation effects which although in most cases are negligible, have their major effect on gamma radiation, viz ${}_{-1}e^0\beta_1 + {}_{+1}e^0\beta_2 = \gamma$ Using Lafleur's theory, this can be reduced to ${}_{-1}e^0\beta_1 + {}_{+1}e^0\beta_2 - (\beta_1 + 3) = \gamma$

From this it may be logically concluded that the stabilization of the nuclei of the product isotopes, as indicated by the neutron/proton ratio, is not complete, and furthermore, are affected to such an extent that ${}_{91}Pa^{235} + {}_{-1}e^0$ would be altered to characteristic due to this

Mr Machado's further comments with regard to these variants to his expounded theories would be appreciated

J Hyams, D Wright, A Ferrey,
Montreal, Canada

No Danger

Mr Machado's letter concerning the Danger of Satellite (AW Nov 25, p 126) worried me only to the extent that someone might take it seriously and quote it as being from your most excellent magazine Charitably I assume that he sent you the letter that should have gone to Super Amazing Science Fantasy If this is not the case let me hasten to reassure him so that he will no longer feel impelled to check under the bed with a geiger counter

A Assume that our γ emitting sputnik is in a circular orbit 400 mi high (This is possible)

B Assume that this Sputnik can collimate a beam of γs to a 1° conical beam with 100% efficiency (i e that all emitted γs are in this beam) (No feasible method for attaining a collimation of this efficiency is known to me)

C Assume that a flux of only 10^6 γs/cm² is adequate to accomplish the transmutation he is worrying about, and further assume that the reaction is, indeed, not only theoretically possible but also probable (The flux assumed is probably low by a factor of at least 10^6, even assuming the reaction is feasible)

D Assume 'Sputnik' is traveling in an orbit which will sweep all weapon storage sites at a velocity of 5 mps, and that the target is in the beam for 1 sec (Actually, it would be in a 1° beam about 1 5 sec)

E Since the reaction depends on pair production, the incident γs must be at least of 1 02 mev Logical sources for γs of this energy might be Co^{60} (half life 5 2 yr) or La^{140} (half life about 40 hr)

F Assume attenuation of γs in accordance with figure 8 35a of "The Effects of Nuclear Weapons" at a four mile slant range (This is very conservative but will give attenuation about 10^{18})

G Going through 'Order of Magnitude" calculations we have

1 Beam area about 9×10^{15} cm²
2 Required flux about 1×10^{4}/cm²/sec
3 Attenuation about 10^{18}

Therefore, the required source strength is $\sim 10^{28}$ γs/sec Now 1 curie $= 3.7 \times 10^{10}$ disintegration/sec

Required source is like 3×10^{18} curies or 3×10^{6} megacuries

1 megacurie of radium $\simeq$ 1,000 kilograms
1 megacurie of Co^{60} (order of magnitude only) $\simeq$ 3 kilograms
1 megacurie of La^{140} (order of magnitude, only) $\simeq$ 3 grams

Now for weights

Co^{60} 3 kg/megacurie x 3×10^{6} megacuries $\simeq 9 \times 10^{6}$ kg $= 9 \times 10^{3}$ tons or — Co^{60} would weigh about 9 000 million tons

La^{140} 3g/mc x 3×10^{6} mc $\simeq 9 \times 10^{6}$ kg $= 9 \times 10^{3}$ tons or La^{140} would weigh about 9 million tons

As noted above the flux assumed is probably low by a factor of 10^6 or more so that the true weight of La^{140} (which is one of the most active γ emitters) is probably more like 9 million million tons

No attempt is made to correct for attenuation of the γ radiation within our 10 trillion ton Sputnik, or to estimate size Production and handling hazards of the 3 million megacurie source would also present shall we say difficulties Take off the lead BVD's Alfred It's safer than you think!

J M Messard
Livermore Calif

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address Letters to the Editor Aviation Week, 330 W 42 St, New York 36 N Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Pilot on Burgess

I would appreciate it if you would publish this letter which I had intended to write to Mr Carter Burgess but because so many of our pilots have expressed the same feelings I would like to have you publish this in your Letters column

Today I found out that Mr Burgess has resigned from the presidency of TWA, due to not agreeing with the policies of "Uncle Howard" (AW Jan 6, p 40) I am not in a position to say who is right or wrong, so I can only express my feelings, which I am sure reflect the opinion of the majority of the employes of TWA In expressing my opinion you must realize that I feel devoted to TWA, as I am sure Mr Burgess must have felt

It is with sincere humility that I express regret that Mr Burgess has found it necessary to leave TWA In the 11 months that he has been back with us he has done wonders with an organization that had been needlessly sick, and has brought it up to the standards that TWA should represent in aviation We need men of Mr Burgess character and strength in TWA and aviation so with his loss two crimes have been committed the loss of Mr Burgess to TWA and his being grounded when aviation means so much to him and he has so much to offer us As one who loves flying I know how much he is giving up but I am sure he won't stay 'grounded' very long

May I now say 'Captain' Burgess, that we of TWA will sincerely miss you and we hope that it will be possible to find as competent a leader for TWA as you have been and lead TWA to the top position it belongs in the air transport business

Thank you for giving TWA the 'Esprit de Corps" needed

TWA First Officer
Los Angeles Calif

More Laurels

Your editorial Laurels for 1957 (AW Dec 30 1957 p 13) has been read with interest and agreement in part The companies people and government organizations cited have made outstanding contributions to the growth of aviation and its related scientific accomplishments

In general, the companies mentioned are all major firms giants in their fields

We recognize that these large companies must lead the way since they have facilities management organizations and the financing needed to carry out large scale scientific programs or large production orders

The smaller companies of which there are thousands are as usual in the background neglected and forgotten The vast network of small firms are to a large extent also an integral part of the backbone of our aviation industry

These small firms who must produce high quality economically and adhere to on time delivery schedules, to a great extent have aided in making the larger firms what they are today It is this team operation that permits so much of the flexibility needed in a highly technological industry

In many cases these small firms, on their own, design develop and test many new components needed in the complex hydraulic electronic and other operational systems of missiles and manned aircraft

Let us not forget the important role that these small firms collectively play in aviation progress How about a "Laurel for 1957" for all these firms

Julius Kendall
Vice President, Arkwin Industries, Inc
Westbury N Y

(We agree Another sprig of 1957 laurels to "the vast network of small firms that are to a large extent an integral part of the backbone of our aviation industry"—Ed)

MOVED UPSTAIRS

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